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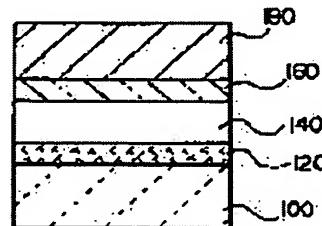
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(54) THIN-FILM EXFOLIATION METHOD, THIN-FILM DEVICE TRANSFER METHOD, THIN-FILM DEVICE, ACTIVE MATRIX SUBSTRATE AND LIQUID CRYSTAL DISPLAYING DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a method, with which a thin-film device formed on a substrate can be exfoliated easily from the substrate.

SOLUTION: An isolation layer 120 is provided on a substrate 100, and a thin-film device 140 such as a TFT, etc., is formed thereon. Exfoliation accelerating ions such as hydrogen ions, for example, are injected into the isolated region 120, in the middle of the formation of the thin film device 140. After the thin-film device 140 has been formed, the thin-film device 140 is connected to a transfer member 180 via a bonded layer 160, and then a laser beam is made to irradiate from the side of the substrate. As a result, the isolation layer 120 is exfoliated, taking advantage of the action of the exfoliation acceleration ions. The thin film device 140 is made to exfoliate from the substrate



100. As a result, the desired thin-film device can be transferred to any type of substrate.

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CLAIMS

[Claim(s)]

[Claim 1] The 1st process which forms a detached core on a substrate, and the 2nd process which forms a thin film device on said detached core, The 3rd process which produces an exfoliation phenomenon in the inside of the layer of said detached core, and/or an interface, and makes said substrate exfoliate from said detached core, The exfoliation approach of the thin film device which is the exfoliation approach of a thin film device of ****(ing), and is characterized by establishing the ion-implantation process which pours ion into said detached core before said 3rd process.

[Claim 2] The exfoliation approach of the thin film device characterized by including the process which makes said ion poured into said detached core gasify at said three processes in claim 1.

[Claim 3] It is the exfoliation approach of the thin film device characterized by including the process in which said 3rd process carries out an optical exposure in claim 2 at an account detached core.

[Claim 4] The exfoliation approach of the thin film device characterized by cutting association of the atom or molecule which constitutes said detached core from said ion-implantation process with said ion in claim 1 thru/or either of 3, and giving a damage beforehand to said detached core.

[Claim 5] The exfoliation approach of the thin film device characterized by changing the property of said detached core with said ion, and weakening the adhesion of said detached core and said substrate beforehand at said ion-implantation process in claim 1 thru/or either of 4.

[Claim 6] It is the exfoliation approach of a thin film device that said 2nd process has a thin film transistor formation process for forming a thin film transistor in claim 1 thru/or either of 5, and said thin film transistor formation process is characterized by carrying out said ion-implantation process after said channel layer formation process including a channel layer formation process.

[Claim 7] Said thin film transistor formation process is the exfoliation approach of the thin film device characterized by carrying out said ion-implantation process after said channel pattern formation process in claim 6 including a channel pattern formation process after said channel layer formation process.

[Claim 8] It is the exfoliation approach of the thin film device characterized by for said ion-implantation process forming a mask among said channel layers in claims 6 or 7 on a channel field and the becoming field, and carrying out.

[Claim 9] It is the exfoliation approach of the thin film device characterized by being the process in which said thin film transistor formation process forms gate dielectric film on this channel pattern after said channel pattern formation process in claim 7, and on this gate dielectric film, and carrying out said ion-implantation process by using said gate electrode as a mask including said channel field and the process which forms a gate electrode in the field which counters.

[Claim 10] It is the exfoliation approach of the thin film device characterized by pouring in simultaneously the impurity ion with which said ion-implantation process is driven into either [at least] the source field in said channel pattern, or a drain field in claims 8 or 9, and said ion which mass is lighter than it and is driven into said detached core.

[Claim 11] Said ion-implantation process is the exfoliation approach of the thin film device characterized by carrying out in front of said crystallization process including the process in which said

thin film transistor formation process forms an amorphous silicon layer as said channel layer in claim 6, and the crystallization process which laser annealing is carried out [process] and crystallizes the account amorphous silicon layer of back to front.

[Claim 12] It is the exfoliation approach of the thin film device characterized by said ion being a hydrogen ion in claim 1 thru/or either of 11.

[Claim 13] The exfoliation approach of the thin film device characterized by making into less than 350 degrees C process temperature of the process carried out after said ion-implantation process in claim 12.

[Claim 14] The thin film device which uses the exfoliation approach of ** for claim 1 thru/or either of 13, exfoliates from said substrate, and changes.

[Claim 15] The active-matrix substrate which is a active-matrix substrate with which the pixel section is constituted including the thin film transistor arranged in the shape of a matrix, and the pixel electrode connected to the end of the thin film transistor, and was manufactured by imprinting the thin film transistor of said pixel section using an approach according to claim 6 to 13.

[Claim 16] The liquid crystal display manufactured using the active-matrix substrate according to claim 15.

[Claim 17] The 1st process which forms the 1st detached core on a substrate, and the 2nd process which forms the transferred layer containing a thin film device on said 1st detached core, The 3rd process which forms the 2nd detached core which consists of water solubility or organic solvent melting nature adhesives on said transferred layer, It borders on said 1st detached core at the 4th process which joins a primary imprint object on said 2nd detached core. The 5th process which removes said substrate from said transferred layer, and the 6th process which joins a secondary imprint object to the underside of said transferred layer, The imprint approach of the thin film device characterized by imprinting said transferred layer which said 2nd detached core is contacted to water or an organic solvent, has the 7th process which removes said primary imprint object from said transferred layer bordering on said 2nd detached core, and contains said thin film device on a secondary imprint object.

[Claim 18] The 1st process which forms the 1st detached core on a substrate, and the 2nd process which forms the transferred layer containing a thin film device on said 1st detached core, The 3rd process which forms the 2nd detached core which consists of the adhesives which have an exfoliation operation by heating or UV irradiation on said transferred layer, It borders on said 1st detached core at the 4th process which joins a primary imprint object on said 2nd detached core. The 5th process which removes said substrate from said transferred layer, and the 6th process which joins a secondary imprint object to the underside of said transferred layer, The imprint approach of the thin film device characterized by imprinting said transferred layer which carries out UV irradiation, has heating or the 7th process which removes said primary imprint object from said transferred layer bordering on said 2nd detached core for said 2nd detached core, and contains said thin film device on a secondary imprint object.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the exfoliation approach of a thin film device, the imprint approach of a thin film device, a thin film device, a active-matrix substrate, and a liquid crystal display.

[0002]

[Background of the Invention] For example, it faces manufacturing the liquid crystal display using a thin film transistor (TFT), and passes through the process which forms a thin film transistor by CVD etc. on a substrate. Since the process which forms a thin film transistor on a substrate is accompanied by high temperature processing, a substrate needs to use what has the high thing, i.e., the softening temperature, and the high melting point of the construction material which is excellent in thermal resistance.

Therefore, in current, quartz glass is used as a substrate which bears the temperature of about 1000 degrees C, and heat-resisting glass is used as a substrate which bears the temperature around 500 degrees C.

[0003] As mentioned above, the substrate carrying a thin film device must satisfy the conditions for manufacturing those thin film devices. That is, it is determined that the substrate to be used will surely fulfill the manufacture conditions of the device carried.

[0004] However, when its attention is paid only to the phase after the substrate carrying thin film devices, such as TFT, is completed, above-mentioned "substrate" is not sometimes necessarily desirable.

[0005] For example, although a quartz substrate, a heat-resisting glass substrate, etc. are used as mentioned above when passing through the manufacture process accompanied by high temperature processing, these are dramatically expensive, therefore cause lifting of a product price.

[0006] Moreover, a glass substrate is heavy and has a property of a crack or a cone. Although what cannot break easily even if it is cheap as much as possible, it is light and it bears and drops also on deformation of some with the liquid crystal display used for portable electronic devices, such as a palmtop computer and a portable telephone, is desirable, actually, a glass substrate is heavy, and is weak to deformation, and it is common that there is fear of destruction by drop.

[0007] That is, it was very difficult for a slot to be between the desirable properties required of the constraint which comes from manufacture conditions, and a product, and to satisfy the conditions and property of these both sides to it.

[0008] Then, an applicant for this patent has proposed the technique of exfoliating from the 1st substrate and making the 2nd substrate imprinting this thin film device, after forming a thin film device on the 1st substrate in the conventional process (Japanese Patent Application No. No. 225643 [eight to]). For this reason, the detached core is formed between the 1st substrate and the thin film device which is a transferred layer. The thin film device which is a transferred layer is made to exfoliate from the 1st substrate, and this transferred layer is made to imprint to a 2nd substrate side by irradiating light at this detached core.

[0009]

[Problem(s) to be Solved by the Invention] According to the experiment of this invention person, when making a thin film device exfoliate from the 1st substrate, it was discovered that an exfoliation phenomenon may not fully arise in a detached core only by irradiating light at a detached core.

[0010] And it became clear that it was [of this invention person] dependent on the property of a detached core wholeheartedly whether it is easy to produce this exfoliation phenomenon according to research.

[0011] Furthermore, the technical problem that it will differ mutually had the laminating relation of the transferred layer to the 1st substrate used when manufacturing a transferred layer, and the laminating relation of the transferred layer to the 2nd substrate which is the imprint place of the transferred layer.

[0012] Then, this invention is to offer the thin film device, active-matrix substrate, and liquid crystal display which use it for the exfoliation approach list of a thin film device compensate [list] that it will be in the condition that a detached core tends to exfoliate, and it was made to make a thin film device exfoliate easily from a substrate, and are manufactured in front of the process which makes a detached core produce an exfoliation phenomenon in exfoliation.

[0013] Other objects of this invention are to offer the imprint approach of the thin film device which can make in agreement the laminating relation of the transferred layer to the substrate used at the time of manufacture of a transferred layer, and the laminating relation of the transferred layer to the imprint object which is the imprint place of the transferred layer.

[0014]

[Means for Solving the Problem] The 1st process at which invention according to claim 1 forms a detached core on a substrate, and the 2nd process which forms a thin film device on said detached core, An exfoliation phenomenon is produced in the inside of the layer of said detached core, and/or an interface, and it is characterized by establishing the ion-implantation process which pours ion into said detached core before said 3rd process in the exfoliation approach of a thin film device of having the 3rd process which makes said substrate exfoliating from said detached core.

[0015] The detached core which has the property which absorbs light that the dependability in device manufacture is high, on substrates, such as a quartz substrate, is prepared, for example, and thin film devices, such as TFT, are formed on the substrate. It joins to the imprint object of a request of a thin film device through the glue line preferably next. Light is irradiated after that at a detached core, and it produces and cheats out of an exfoliation phenomenon in the detached core. Thereby, a thin film device can be made to exfoliate from a substrate by applying the force to a substrate.

[0016] The exfoliation phenomenon of the detached core in an exfoliation process can become remarkable, and a thin film device can be made to exfoliate from a substrate certainly by pouring ion into a detached core in front of an exfoliation process at this time.

[0017] Here, by pouring ion into a detached core beforehand, the operation defined as either of claims 2-5 is made, and the exfoliation phenomenon of a detached core becomes remarkable.

[0018] According to claim 2, the process by which said ion poured into said detached core is gasified is included in said three processes. If the ion in a detached core is gasified, in a detached core, internal pressure will arise and the exfoliation phenomenon will be promoted.

[0019] In this case, light can be irradiated at a detached core and the ion for exfoliation can be made to gasify by that light, as shown in claim 3. If an optical exposure is carried out at this time [side / of a substrate / rear-face], the quantity of light by which optical incidence is carried out to a thin film device layer can be reduced, and degradation of that property can be prevented.

[0020] According to claim 4, at said ion-implantation process, association of the atom or molecule which constitutes said detached core with said ion is cut, and a damage is beforehand given to said detached core. Therefore, the exfoliation phenomenon in the detached core produced at a subsequent exfoliation process is promoted.

[0021] According to claim 5, at said ion-implantation process, the property of said detached core is changed with said ion, and the adhesion of said detached core and said substrate is weakened beforehand. Therefore, the exfoliation phenomenon in the detached core produced at a subsequent

exfoliation process is promoted.

[0022] Invention of claim 6 has a thin film transistor formation process for said 2nd process to form a thin film transistor in claim 1 thru/or either of 5, and said thin film transistor formation process is characterized by carrying out said ion-implantation process after said channel layer formation process including a channel layer formation process.

[0023] A channel formation process turns into a high-temperature-processing process as compared with other processes. Therefore, it is because there is a possibility that ion may be emitted from a detached core at the time of subsequent high temperature processing when the ion for exfoliation phenomenon acceleration is poured in before that at the detached core.

[0024] In claim 6, said thin film transistor formation process is characterized by carrying out said ion-implantation process after said channel pattern formation process including a channel pattern formation process after said channel layer formation process by invention of claim 7.

[0025] If the channel pattern is formed, even if it pours in the ion for exfoliation phenomenon acceleration from a channel pattern side, the area of the channel pattern itself which can serve as a failure of the impregnation will decrease. Therefore, it becomes that it is easy to make ion reach to a detached core.

[0026] Invention of claim 8 is characterized by for said ion-implantation process forming a mask among said channel layers on a channel field and the becoming field, and carrying it out in claims 6 or 7.

[0027] It is because there is a possibility that transistor characteristics may deteriorate when ion is poured into a channel field. In addition, the process which carries out the mask of the channel field and carries out an ion implantation may be before channel pattern formation or after formation.

[0028] In claim 9, said thin film transistor formation process is characterized by carrying out said ion-implantation process by using said gate electrode as a mask after said channel pattern formation process including the process which forms gate dielectric film on this channel pattern, and the process which forms a gate electrode on this gate dielectric film in claim 7.

[0029] Since a gate electrode is formed in a channel and the location which counters, a gate electrode can be used also [field / channel] as a mask with which ion prevents pouring into a channel field. In addition, according to the acceleration voltage of ion, a mask may be further formed on a gate electrode.

[0030] It is characterized by invention of claim 10 pouring in simultaneously the impurity ion with which said ion-implantation process is driven into either [at least] the source field in said channel pattern, or a drain field, and said ion which mass is lighter than it and is driven into said detached core in claims 8 or 9.

[0031] If it carries out like this, the ion-implantation process to a detached core and the impurity ion-implantation process to the source and/or a drain field can be made to serve a double purpose. In addition, since mass is lighter than impurity ion, ion can reach to the detached core in a location deeper than the source and a drain field.

[0032] Said ion-implantation process is characterized by carrying out in front of said crystallization process including the crystallization process which said thin film transistor formation process carries out laser annealing of the process in which an amorphous silicon layer is formed as said channel layer, and its account amorphous silicon layer of back to front in claim 6, and invention of claim 11 crystallizes.

[0033] Crystallinity is raised by the subsequent laser annealing process even if a damage should arise in a channel layer by operation of an ion-implantation process.

[0034] Invention of claim 12 is characterized by said ion being a hydrogen ion in claim 1 thru/or either of 11.

[0035] If a hydrogen ion is poured into a detached core, it can be made to contribute to the operation shown in each of claims 2-4. Since mass is lighter than the source and the impurity ion (boron, Lynn, etc.) driven into a drain, especially the hydrogen ion also fits implementation of invention of claim 9. In addition, as ion which mainly produces gasification of claim 2, nitrogen ion etc. can be mentioned other than a hydrogen ion. Moreover, as ion which mainly produces the damage of claims 3 and 4, or adhesion lowering, Si ion etc. can be mentioned other than a hydrogen ion.

[0036] Invention of claim 13 is characterized by making into less than 350 degrees C process

temperature of the process carried out after said ion-implantation process in claim 12.

[0037] Since it begins to escape from the hydrogen poured into the detached core by being heated by 350 degrees C or more, as for the process which needs the process temperature of 350 degrees C or more, it is desirable to carry out, before the ion-implantation process to a detached core.

[0038] Invention of claim 14 defines the thin film device which uses the exfoliation approach of ** for claim 1 thru/or either of 13, exfoliates from said substrate, and changes. Since the exfoliation from a detached core is easy for this thin film device, there is little mechanical pressure which acts at the time of exfoliation, it ends, and can lessen the defect depending on the magnitude of that load.

[0039] Invention of claim 15 is a active-matrix substrate with which the pixel section is constituted including the thin film transistor arranged in the shape of a matrix, and the pixel electrode connected to the end of the thin film transistor, and defines the active-matrix substrate manufactured by imprinting the thin film transistor of said pixel section using an approach according to claim 6 to 13.

[0040] This active-matrix substrate as well as invention of claim 13 can lessen a defect.

[0041] Invention of claim 16 defines the liquid crystal display manufactured using the active-matrix substrate according to claim 15.

[0042] Since the active-matrix substrate of claim 15 is used for this liquid crystal display, its defect as the whole liquid crystal display also decreases.

[0043] The imprint approach of the thin film device concerning invention of claim 17 The 1st process which forms the 1st detached core on a substrate, and the 2nd process which forms the transferred layer containing a thin film device on said 1st detached core, The 3rd process which forms the 2nd detached core which consists of water solubility or organic solvent melting nature adhesives on said transferred layer, It borders on said 1st detached core at the 4th process which joins a primary imprint object on said 2nd detached core. The 5th process which removes said substrate from said transferred layer, and the 6th process which joins a secondary imprint object to the underside of said transferred layer, Said 2nd detached core is contacted to water or an organic solvent, and it has the 7th process which removes said primary imprint object from said transferred layer bordering on said 2nd detached core, and is characterized by imprinting said transferred layer containing said thin film device on a secondary imprint object.

[0044] After removing the 1st detached core and joining a secondary imprint object to the underside from the underside of a transferred layer, it is made to secede from a primary imprint object from a transferred layer bordering on the 2nd detached core according to invention of claim 17. If it carries out like this, a secondary imprint object will exist in the location in which the original substrate was located to a transferred layer, and the laminating relation of the transferred layer to the original substrate and the laminating relation of the transferred layer to a secondary imprint object are in agreement. here, since water-soluble adhesives or organic solvent melting nature adhesives is used as the 2nd detached core, the 2nd detached core is contacted to water or an organic solvent making it secede from a primary imprint object -- being sufficient.

[0045] By the imprint approach of the thin film device concerning invention of claim 18, as the 2nd detached core under approach invention of claim 17, it replaces with the above-mentioned adhesives and the adhesives which can exfoliate by heating or ultraviolet rays are used.

[0046] In this case, if the 2nd detached core is contacted in the adhesives which can exfoliate by heating or ultraviolet rays making it secede from a primary imprint object, the laminating relation of the transferred layer to the original substrate and the laminating relation of the transferred layer to a secondary imprint object can be made in agreement like invention of claim 17.

[0047]

[Embodiment of the Invention] Next, the gestalt of operation of this invention is explained with reference to a drawing.

[0048] <Gestalt of the 1st operation> drawing 1 - drawing 6 are drawings for explaining the imprint approach of the thin film device which will be the requisite for this invention.

[0049] As shown in [process 1] drawing 1, a detached core (optical absorption layer) 120 is formed on a substrate 100.

[0050] Hereafter, a substrate 100 and a detached core 120 are explained.

[0051] ** What has the translucency which light may penetrate is used for the explanation substrate 100 about a substrate 100.

[0052] In this case, as for the permeability of light, it is desirable that it is 10% or more, and it is more desirable that it is 50% or more. When this permeability is too low, attenuation (loss) of light becomes large and needs the big quantity of light by exfoliating a detached core 120.

[0053] Moreover, as for a substrate 100, it is desirable to consist of reliable ingredients, and it is desirable to consist of ingredients which were excellent in thermal resistance especially. Although the reason has what process temperature becomes high depending on the class and formation approach (for example, about 350-1000 degrees C) in case it forms the transferred layer 140 and interlayer 142 who mention later, it is because the width of face of setting out of membrane formation conditions, such as the temperature condition, will spread even in such a case on the occasion of formation of the transferred layer 140 grade to a substrate 100 top if the substrate 100 is excellent in thermal resistance.

[0054] Therefore, a substrate 100 has a desirable consisting-of [the strain point]-ingredients more than Tmax thing, when the maximum temperature in the case of formation of the transferred layer 140 is set to Tmax. A thing 350 degrees C or more has a desirable strain point, and, specifically, the component of a substrate 100 has a more desirable thing 500 degrees C or more. As such a thing, the heat resisting glass of quartz glass, Corning 7059, and NEC glass OA-2 grade is mentioned, for example.

[0055] Moreover, although especially the thickness of a substrate 100 is not limited, it is desirable that it is about 0.1-5.0mm, and it is usually more desirable that it is about 0.5-1.5mm. If the thickness of a substrate 100 is too thin, strong lowering will be caused, and if too thick, when the permeability of a substrate 100 is low, it will become easy to produce attenuation of light. In addition, when the permeability of the light of a substrate 100 is high, the thickness may exceed said upper limit. In addition, as for the thickness of a substrate 100, it is desirable that it is uniform so that light can be irradiated at homogeneity.

[0056] ** The explanation detached core 120 of a detached core 120 is receiving any one or two or more operations of physical operations (light, heat, etc.), chemical operations (chemical reaction with a drug solution etc.), or mechanical works (the hauling force, oscillation, etc.), that bonding strength is decreased or extinguished and this urges separation of a substrate 100 to it through this detached core 120.

[0057] The light which it considers as this detached core 120, for example, is irradiated can be absorbed, and what has a property which produces exfoliation (henceforth "exfoliation in a layer" and "interfacial peeling") in the inside of that layer and/or an interface can be mentioned. What it arises that the bonding strength between the atoms of the matter which constitutes a detached core 120, or between molecules disappears or decreases, i.e., ablation, and results in the exfoliation in a layer and/or interfacial peeling by the exposure of light preferably is good.

[0058] Furthermore, a gas may be emitted by the exposure of light from a detached core 120, and the separation effectiveness may be discovered. That is, a detached core 120 absorbs light, it becomes a gas to the case where the component contained in the detached core 120 serves as a gas, and it is emitted for a moment, the steam is emitted, and it may contribute to separation.

[0059] In this invention, after forming the detached core 120 which has such a property, it is the description to pour in the ion for exfoliation acceleration into a detached core 120, and, thereby, the exfoliation phenomenon in the detached core 120 in a subsequent process is promoted. Therefore, a class will not be asked if the exfoliation phenomenon by the physical operation, chemical operation, or mechanical work mentioned above is promoted as ion for exfoliation acceleration.

[0060] Next, as a presentation of such a detached core 120, what is indicated by following A-E is mentioned, for example.

[0061] A. Amorphous silicon (a-Si)

Hydrogen (H) may contain in this amorphous silicon. In this case, as for the content of H, it is desirable that it is extent more than 2 atom %, and it is more desirable that it is 2 - 20 atom % extent. Thus, if specified quantity content of the hydrogen (H) is carried out, by making light an exposure behind,

hydrogen will be emitted, internal pressure will occur in a detached core 120, and it will become the force in which it exfoliates an up-and-down thin film. The content of the hydrogen in an amorphous silicon (H) can be adjusted by setting up suitably conditions, such as membrane formation conditions, for example, the gas presentation in CVD, gas pressure, a gas ambient atmosphere, a quantity of gas flow, temperature, substrate temperature, and charge power.

[0062] With the gestalt of this operation, the ion implantation of the hydrogen ion can be carried out as ion for exfoliation acceleration at one after formation of an amorphous silicon layer of stages as hydrogen is made to contain in a detached core 120 according to this process condition and also being mentioned later. Thereby, the hydrogen more than a constant rate can be made to contain in an amorphous silicon layer, without being influenced by the process conditions of an amorphous silicon.

[0063] B. As various oxide ceramics, such as silicon oxide or a silicic-acid compound, titanium oxide or a titanic-acid compound, a zirconium dioxide or a zirconic acid compound, a lanthanum trioxide, or a lanthanum oxidation compound, ***** (ferroelectric), or semi-conductor silicon oxide, SiO, SiO₂, and Si₃O₂ are mentioned, and K₂SiO₃, Li₂SiO₃, CaSiO₃ and ZrSiO₄, and Na₂SiO₃ are mentioned as a silicic-acid compound, for example.

[0064] TiO, Ti₂O₃, and TiO₂ mention as titanium oxide -- having -- as a titanic-acid compound -- BaTiO₄, BaTiO₃, Ba₂Ti 9O₂₀, BaTi 5O₁₁, and CaTiO₃, SrTiO₃, PbTiO₃, MgTiO₃, ZrTiO₂, SnTiO₄ and aluminum₂ -- TiO₅ and FeTiO₃ are mentioned.

[0065] As a zirconium dioxide, ZrO₂ is mentioned and BaZrO₃, ZrSiO₄, PbZrO₃, MgZrO₃, and K₂ZrO₃ are mentioned as a zirconic acid compound, for example.

[0066] C. The ceramics or dielectrics (ferroelectric), such as PZT, PLZT, PLLZT, and PBZT
D. As nitride-ceramics E. organic polymeric-materials organic polymeric materials, such as silicon nitride, nitriding aluminum, and titanium nitride - CH-, -CO- (ketone), -CONH- (amide), -NH- (imide), - As long as it is what has association (these association is cut by the exposure of light) of COO- (ester), - N=N- (azo), -CH=N- (CIF), etc., and the thing which has many these association especially, what kind of thing may be used. Moreover, organic polymeric materials may have aromatic hydrocarbon (1, two or more benzene rings, or condensed ring of those) in a constructive mood.

[0067] As an example of such organic polymeric materials, polyethylene, polyolefine like polypropylene, polyimide, a polyamide, polyester, polymethylmethacrylate (PMMA), polyphenylene sulfide (PPS), polyether sulphone (PES), an epoxy resin, etc. are raised.

[0068] F. As a metal metal, the alloy containing at least one of aluminum, Li, Ti, Mn, In, Sn, Y, La, Ce, Nd, Pr, Gd, Sm, or sorts of these is mentioned, for example.

[0069] Moreover, although the thickness of a detached core 120 changes with terms and conditions, such as a presentation of the exfoliation object or a detached core 120, lamination, and the formation approach, it is desirable that it is 1nm - about 20 micrometers, it is more desirable that it is 5nm - about micrometers, and it is usually still more desirable [thickness] that it is 5nm - about 1 micrometer. While enlarging power (quantity of light) of light in order to secure the good detachability of a detached core 120 if the homogeneity of membrane formation is spoiled, nonuniformity may arise in exfoliation, when the thickness of a detached core 120 is too small, and thickness is too thick, in case a detached core 120 is removed behind, the activity takes time amount. In addition, as for the thickness of a detached core 120, it is desirable that it is uniform as much as possible.

[0070] Especially the formation approach of a detached core 120 is not limited, but is suitably chosen according to terms and conditions, such as a film presentation and thickness. For example, it CVD(s) (MOCVD and low voltage -- CVD and ECR-CVD are included). Vacuum evaporationo, molecular beam deposition (MB), sputtering, ion plating, The various gaseous-phase forming-membranes methods, such as PVD, electroplating, immersion plating (dipping), various plating, such as electroless deposition, and the Langmuir pro jet (LB) -- law -- The applying methods, such as a spin coat, a spray coat, and a roll coat, various print processes, a replica method, the ink jet method, a powder jet process, etc. are mentioned, and it can also form or more [of these] combining two.

[0071] For example, when the presentation of a detached core 120 is an amorphous silicon (a-Si), it is desirable to form membranes by CVD especially low voltage CVD, or plasma CVD.

[0072] Moreover, when a detached core 120 is constituted from ceramics by the sol-gel method, or when it constitutes from organic polymeric materials, it is desirable the applying method and to form membranes with a spin coat especially.

[0073] As shown in [a process 2], next drawing 2, the transferred layer (thin film device layer) 140 is formed on a detached core 120. Although the detail after this process 2 is later explained with reference to drawing 8 - drawing 18, it is carrying out the ion-implantation process for exfoliation acceleration to a detached core 120 with the gestalt of this operation in the middle of the process of drawing 8 - drawing 13.

[0074] The expanded sectional view of K part (part shown by surrounding with 1 dotted-line chain line in drawing 2) of this thin film device layer 140 is shown in the right-hand side of drawing 2. It is constituted including TFT (thin film transistor) formed on SiO₂ film (middle class) 142, and the thin film device layer 140 possesses the source and the drain layer 146 which this TFT introduced n mold impurity into the polish recon layer, and were formed, the channel layer 144, gate dielectric film 148, the gate electrode 150, an interlayer insulation film 154, and the electrode 152 that consists of aluminum so that it may be illustrated.

[0075] Although SiO₂ film is used with the gestalt of this operation as an interlayer prepared in contact with a detached core 120, the insulator layer of others, such as Si₃N₄, can also be used. Although the thickness of SiO₂ film (interlayer) is suitably determined according to the formation object or extent of a function which can be demonstrated, it is desirable that it is 10nm - about 5 micrometers, and it is usually more desirable that it is 40nm - about 1 micrometer. What demonstrates at least one of the functions as the protective layer which an interlayer is formed for the various object, for example, protects the transferred layer 140 physically or chemically, an insulating layer, a conductive layer, the protection-from-light layer of laser light, the barrier layer for migration prevention, and a reflecting layer is mentioned.

[0076] In addition, the middle class, such as SiO₂ film, may not be formed depending on the case, but the direct transferred layer (thin film device layer) 140 may be formed on a detached core 120.

[0077] The transferred layer 140 (thin film device layer) is a layer containing thin film devices, such as TFT as shown in the right-hand side of drawing 2.

[0078] As a thin film device, besides TFT, for example, a thin-film diode, The optoelectric transducer (the photosensor, solar battery) and silicon resistance element which consist of PIN junction of silicon, Other thin film semiconductor devices, an electrode (example: a transparent electrode like ITO and the mesa film), Actuators, such as a switching element, memory, and a piezoelectric device, a micro mirror (piezo thin film ceramics), There are a micro MAG device which combined a magnetic-recording thin film head, a coil, an inductor, the charge of a thin film high magnetic-permeable material, and them, a filter, reflective film, a dichroic mirror, etc.

[0079] Such a thin film device is formed through usually comparatively high process temperature by relation with the formation approach. Therefore, as mentioned above in this case, as a substrate 100, the thing which has high dependability and which can bear that process temperature is needed.

[0080] As shown in [a process 3], next drawing 3, the thin film device layer 140 is joined to the imprint object 180 through a glue line 160 (adhesion).

[0081] As a suitable example of the adhesives which constitute a glue line 160, various hardening mold adhesives, such as photo-curing mold adhesives, such as reaction hardening mold adhesives, heat-curing mold adhesives, and ultraviolet curing mold adhesives, and aversion hardening mold adhesives, are mentioned. As a presentation of adhesives, what kind of thing is sufficient as an epoxy system, an acrylate system, a silicone system, etc., for example. Formation of such a glue line 160 is made for example, by the applying method.

[0082] After applying hardening mold adhesives on the transferred layer (thin film device layer) 140 and joining the imprint object 180 on it when using said hardening mold adhesives for example, said hardening mold adhesives are stiffened by the hardening approach according to the property of hardening mold adhesives, and the transferred layer (thin film device layer) 140 and the imprint object 180 are pasted up, and it fixes. [0083] when adhesives are photo-curing molds, light is irradiated from

the substrate of light transmission nature, and both the outsides of an imprint object or -- from one outside of the substrate 100 of light transmission nature, or the imprint object 180 of light transmission nature. As adhesives, photo-curing mold adhesives, such as an ultraviolet curing mold which cannot affect a thin film device layer easily, are desirable.

[0084] Water-soluble adhesives can also be used as a glue line 160. As this kind of water-soluble adhesives, it is KEMISHIRU made from for example, KEMITEKKU, Inc. Three Bond 3046 (trade name) by U-451D (trade name) and Three Bond Co., Ltd. etc. can be mentioned.

[0085] The adhesives which have melting nature to various kinds of organic solvents as a glue line 160 can also be used.

[0086] As a glue line 160, the adhesives which present an exfoliation operation with heating can also be used. As this kind of adhesives, RIBAARUFA made from for example, Japanese east DENKO (trade name) can be used.

[0087] As a glue line 160, the adhesives which present an exfoliation operation by UV irradiation can also be used. As this kind of adhesives, the dicing tape D-210 for glass ceramics by LINTEC Corp. and D-636 can be used.

[0088] In addition, unlike a graphic display, a glue line 160 may be formed in the imprint object 180 side, and the transferred layer (thin film device layer) 140 may be pasted up on it. In addition, when imprint object 180 the very thing has an adhesion function, for example, formation of a glue line 160 may be omitted.

[0089] although not limited especially as an imprint object 180 -- a substrate (plate) -- especially a transparency substrate is mentioned. In addition, such a substrate may be monotonous or may be a bow plate. Moreover, compared with said substrate 100, properties, such as thermal resistance and corrosion resistance, may be inferior in the imprint object 180. It is because the reason forms the transferred layer (thin film device layer) 140 in a substrate 100 side in this invention, and imprints the transferred layer (thin film device layer) 140 on the imprint object 180 after that, so it does not depend on the temperature conditions in the case of formation of the transferred layer (thin film device layer) 140 etc. for the property required of the imprint object 180, especially thermal resistance.

[0090] Therefore, when the maximum temperature in the case of formation of the transferred layer 140 is set to Tmax, a glass transition point (Tg) or softening temperature can use the following [Tmax] as a component of the imprint object 0. For example, a glass transition point (Tg) or softening temperature can constitute more preferably 800 degrees C or less of 500 degrees C or less of imprint objects 180 from an ingredient 320 degrees C or less still more preferably.

[0091] Moreover, although what has a certain amount of rigidity (reinforcement) as a mechanical property of the imprint object 180 is desirable, you may have flexibility and elasticity.

[0092] As a component of such an imprint object 180, various synthetic resin or various glass material are mentioned, and various synthetic resin and the usual cheap (low melting point) glass material are desirable especially.

[0093] As synthetic resin, any of thermoplastics and thermosetting resin are sufficient. For example, polyethylene, a polo propylene, an ethylene-pre pyrene copolymer, Polyolefines, such as an ethylene-vinylacetate copolymer (EVA), annular polyolefine, Denaturation polyolefine, a polyvinyl chloride, a polyvinylidene chloride, polystyrene, A polyamide, polyimide, polyamidoimide, a polycarbonate, Polly (4-methyl BENTEN -1), An ionomer, acrylic resin, polymethylmethacrylate, an acrylic-styrene copolymer (AS resin), Butadiene Styrene, a polio copolymer (EVOH), polyethylene terephthalate (PET), Polyester, such as polyp CHIREN terephthalate (PBT) and PURISHI clo hexane terephthalate (PCT), A polyether, a polyether ketone (PEK), a polyether ether ketone (PEEK), Polyether imide, polyacetal (POM), polyphenylene oxide, Denaturation polyphenylene oxide, polyarylate, aromatic polyester (liquid crystal polymer), Polytetrafluoroethylene, polyvinylidene fluoride, other fluorine system resin, A styrene system, a polyolefine system, a polyvinyl chloride system, a polyurethane system, Various thermoplastic elastomer, such as a fluororubber system and a chlorinated polyethylene system, EBOKISHI resin, phenol resin, a urea resin, melamine resin, unsaturated polyester, The copolymer which is mainly concerned with these, a blend object, a polymer alloy, etc. are mentioned,

and silicone resin, polyurethane, etc. can be used combining 1 of sorts of these, and two sorts or more (as a layered product for example, more than two-layer).

[0094] As glass material, silicic-acid glass (quartz glass), silicic-acid alkali glass, soda lime glass, potash lime glass, lead (alkali) glass, barium glass, borosilicate glass, etc. are mentioned, for example. Among these, compared with silicic-acid glass, the melting point is low, and shaping and processing are also comparatively easy the melting point, and, moreover, things other than silicic-acid glass have it, and are desirable. [cheap]

[0095] When using what consisted of synthetic resin as an imprint object 180, while being able to fabricate the large-scale imprint object 180 in one, even if it is complicated configurations, such as what has a bow side and irregularity, it can manufacture easily, and the various advantages that ingredient cost and a manufacturing cost are also cheap can be enjoyed. Therefore, the activity of synthetic resin is advantageous when manufacturing a large-sized and cheap device (for example, liquid crystal display).

[0096] In addition, the imprint object 180 may constitute some devices like what constitutes the device which became independent in itself like a liquid crystal cell, a light filter and an electrode layer, a dielectric layer, an insulating layer, and a semiconductor device.

[0097] Furthermore, the imprint objects 180 may be matter, such as a metal, ceramics, a stone, and timber paper, and may be on the front face of the structures, such as a wall, a column, head lining, and a windowpane, further on the field (up [of the front-face top of the field top of a clock, and an air-conditioner, and a printed circuit board] etc.) of the arbitration which constitutes a certain goods.

[0098] As shown in [a process 4], next drawing 4, light is irradiated from the rear-face side of a substrate 100.

[0099] After this light penetrates a substrate 100, it is irradiated by the detached core 120. Thereby, the exfoliation in a layer and/or interfacial peeling arise in a detached core 120, and bonding strength is decreased or extinguished.

[0100] It is presumed that it is what is depended on phase changes, such as that ablation produces the principle which the exfoliation in a layer and/or interfacial peeling of a detached core 120 produce in the component of a detached core 120 and bleedoff of the gas contained in the detached core 120, melting further produced immediately after an exposure, and evapotranspiration.

[0101] The fixed ingredient (component of a detached core 120) which absorbed exposure light is excited photochemistry-wise or thermally, ablation means association of the atom of the front face and interior or a molecule being cut, and emitting here, and it mainly appears as a phenomenon in which all or a part of component of a detached core 120 produces phase changes, such as melting and evapotranspiration (evaporation). Moreover, by said phase change, it may be in a minute firing condition and bonding strength may decline.

[0102] Conditions, such as a presentation of a detached core 120, and a class of light irradiated as one of the factor of the, wavelength, reinforcement, the attainment depth, are mentioned by in addition to this being influenced by various factors they are [whether a detached core 120 produces the exfoliation in a layer interfacial peeling is produced, or] the both.

[0103] Here, with the gestalt of this operation, after formation of a detached core 120, in order to make detached core 120 the very thing produce an exfoliation phenomenon more certainly at this 4th process, the ion for exfoliation acceleration is poured in.

[0104] This ion for exfoliation acceleration promotes three either of the followings, or the exfoliation phenomenon of the detached core [in / for an operation of two or more combination / nothing and the 4th process] 120 at least.

[0105] The ion for exfoliation acceleration, for example, the hydrogen, (H) or nitrogen (N) with which one of them was poured into the detached core 120 by operation of this 4th process is gasified, and, thereby, exfoliation of a detached core 120 is promoted.

[0106] In the ion-implantation process for exfoliation acceleration, other one cut association of the atom or molecule which constitutes a detached core 120 with the ion for exfoliation acceleration, for example, hydrogen, (H), nitrogen (N), or silicon (Si), and it has given the damage beforehand to the detached core 120. Therefore, in the detached core 120 to which the damage was given beforehand, exfoliation arises

comparatively easily by operation of the 4th process.

[0107] In the ion-implantation process for exfoliation acceleration, one of further others changes the property of a detached core 120 with the ion for exfoliation acceleration, for example, hydrogen, (H), nitrogen (N), or silicon (Si), and the adhesion of a detached core 120 and a substrate 100 has weakened it beforehand. Also in this case, in the detached core 120 which the adhesion with a substrate was able to weaken, exfoliation arises comparatively easily by operation of the 4th process.

[0108] As a light irradiated at the 4th process, if a detached core 120 is made to start the exfoliation in a layer, and/or interfacial peeling, what kind of thing may be used, for example, an X-ray, ultraviolet rays, the light, infrared radiation (heat ray), a laser beam, a millimeter wave, microwave, an electron ray, a radiation (alpha rays, beta rays, gamma ray), etc. will be mentioned. A laser beam is desirable at the point of being easy to produce exfoliation (ablation) of a detached core 120 also in it.

[0109] As laser equipment made to generate this laser beam, although various gas laser, solid state laser (semiconductor laser), etc. are mentioned, excimer laser, Nd-YAG laser, Ar laser, a CO₂ laser, a CO laser, helium-Ne laser, etc. are used suitably, and especially excimer laser is desirable also in it.

[0110] Since it outputs high energy in a short wavelength region, extremely, excimer laser can make a detached core 120 produce ablation for a short time, and it can exfoliate a detached core 120, without making the imprint object 180 and substrate 100 grade which therefore adjoin produce most temperature rises (i.e., without it producing degradation and breakage).

[0111] Moreover, when it makes it faced that a detached core 120 produces ablation and there is a wavelength dependency of light, as for the wavelength of the laser beam irradiated, it is desirable that it is 100nm - about 350nm.

[0112] An example of permeability to the wavelength of light of a substrate 100 is shown in drawing 7. It has the property that permeability increases steeply to the wavelength of 200nm so that it may be illustrated. In such a case, light (wavelength of 308nm) with a wavelength of 210nm or more, for example, Xe-Cl excimer laser light, KrF laser light (wavelength of 248nm), etc. are irradiated.

[0113] Moreover, when making a detached core 120 cause phase changes, such as a gas evolution, evaporation, and sublimation, and giving a separation property to it, as for the wavelength of the laser beam irradiated, it is desirable that it is about 350 to 1200nm.

[0114] Moreover, as for especially the energy density in the case of excimer laser, it is desirable the energy density of the laser beam irradiated and to consider as about two 10 - 5000 mJ/cm, and it is more desirable to consider as about two 100 - 500 mJ/cm. Moreover, as for irradiation time, it is desirable to be referred to as about 1 - 1000ns, and it is more desirable to be referred to as about 10 - 100ns. When sufficient ablation etc. does not arise, and an energy density is high, when an energy density is low or irradiation time is short, or irradiation time is long, there is a possibility of having an adverse effect on the transferred layer 140 by the exposure light which penetrated the detached core 120.

[0115] In addition, as a cure in case the exposure light which penetrated the detached core 120 reaches even the transferred layer 140 and does an adverse effect, as shown in drawing 30, there is the approach of forming the metal membranes 124, such as a tantalum (Ta), on a detached core (laser absorption layer) 120, for example. Thereby, it is thoroughly reflected by the interface of a metal membrane 124, and the laser light which penetrated the detached core 120 does not have an adverse effect on the thin film device above it.

[0116] Next, the force is applied to a substrate 100 and this substrate 100 is made to secede from a detached core 120; as shown in drawing 5. Although not illustrated in drawing 5, a detached core may adhere on a substrate 100 after this balking.

[0117] Next, as shown in drawing 6, the extant detached core 120 is removed by the approach which combined approaches, such as washing, etching, ashing, and polish, or these. It means that the transferred layer (thin film device layer) 140 had been imprinted by the imprint object 180 by this.

[0118] In addition, when a part of detached core has adhered also to the substrate 100 from which it seceded, it removes similarly. In addition, when the substrate 100 consists of an expensive ingredient like quartz glass, and a rare ingredient, reuse (recycle) is preferably presented with a substrate 100. That is, this invention can be applied to the substrate 100 to reuse, and usefulness is high.

[0119] The imprint to the imprint object 180 of the transferred layer (thin film device layer) 140 is completed through each above process. Then, conductive layers, such as clearance of SiO₂ film which adjoins the transferred layer (thin film device layer) 140, and wiring of a up to [the transferred layer 140], formation of a desired protective coat, etc. can also be performed.

[0120] Thus, transferred layer (thin film device layer) 140 the very thing which is an exfoliated object is not exfoliated directly. Since it exfoliates in the detached core joined to the transferred layer (thin film device layer) 140, Irrespective of the property of an exfoliated object (transferred layer 140), conditions, etc., easily and certainly, it can exfoliate in homogeneity (imprint), there is also no damage to the exfoliated object (transferred layer 140) in accordance with exfoliation actuation, and the high dependability of the transferred layer 140 can be maintained.

[0121] Next, TFT of for example, CMOS structure is formed as a thin film device layer 140 on a substrate 100 and a detached core 120, and the example of the concrete manufacture process in the case of imprinting this on an imprint object is explained using drawing 8 - drawing 18. In addition, the ion-implantation process for exfoliation acceleration carried out in the middle of this process is also explained.

[0122] (Process 1) as shown in drawing 8, on the translucency substrate (for example, quartz substrate) 100, laminating formation of a detached core (for example, LPCVD amorphous silicon layer formed of law) 120, an interlayer (for example, SiO₂ film) 142, and the amorphous silicon layer (for example, LPCVD -- formed of law) 143 is carried out one by one, then laser light is irradiated from the upper part all over the amorphous silicon layer 143, and annealing is given. Thereby, the amorphous silicon layer 143 is recrystallized and turns into a polish recon layer. In addition, when carrying out laser annealing in this case with a beam scan, it is desirable in the same part that an optical exposure is carried out 2 times or more so that the beam cores of the beam of each time may lap unlike the beam scan to the above-mentioned detached core 120 (it removes in the case of a Gaussian beam). In this case, it is because there are no evils, such as optical leakage, and the amorphous silicon layer 143 can fully be recrystallized by carrying out a multiplex exposure.

[0123] If it is after formation of a detached core 120 and is before the laser annealing process for crystallization as an operation stage of the impregnation process of the ion for exfoliation acceleration, it is desirable at the point that an ion implantation can be carried out without needing a mask.

[0124] Therefore, as the operation stage, it is after formation of the detached core 120 of (A) drawing 8, is after formation of an interlayer's 142 (B) interlayer 142 before formation, is after formation of the amorphous silicon layer 143 (before [C]) formation of the amorphous silicon layer 143, and becomes either in front of the laser annealing process for the crystallization. This (A) In - (C), the operation stage of (C) is the most desirable. In the reason, the formation process of the amorphous silicon layer 143, i.e., the formation process of a channel layer, serves as process temperature of about 425 degrees C in the actual condition. When the hydrogen ion is already poured into the detached core 120 as in this case, for example, ion for exfoliation acceleration, there is a possibility that hydrogen may escape from and come out of a detached core 120 at the temperature of 350 degrees C or more. Therefore, as for the impregnation process of the ion for exfoliation acceleration, it is desirable to carry out with the operation stage after the channel stratification (C). However, since there is such no limit depending on the class of ion for exfoliation acceleration, an operation stage (A) and (B) can also be carried out. Moreover, it is desirable on transistor characteristics that the damage resulting from impregnation of the ion for exfoliation acceleration has not arisen in the layer after laser annealing of the amorphous silicon layer 143 was carried out and it was polycrystal-ized. In being (C), even if there is no generating of a damage itself in (A) and (B), and a damage arises in amorphous silicon layer 143 the very thing, the effect of the damage will be reduced according to a subsequent crystallization process.

[0125] In addition, this ion-implantation process for exfoliation acceleration can be carried out using well-known ion implantation equipment. That is, if a hydrogen ion is poured in, for example, the gas containing hydrogen is plasma-ized and the hydrogen ion generated by it can be poured into a detached core 120 by accelerating by electric field.

[0126] As an operation stage (D) of an ion-implantation process, you may be after laser annealing. In

this case, transistor characteristics will not be degraded, if the mask of the part used as a channel field is carried out and it carries out an ion implantation. In addition, a mask is removed after an ion-implantation process. As it is alike (process 2), then is shown in drawing 9, patterning of the polish recon layer obtained by laser annealing is carried out, and Islands 144a and 144b are formed as a channel pattern.

[0127] The ion-implantation process for exfoliation acceleration can be carried out after the 2nd process (channel pattern formation process) as the operation stage (E) besides (A) - (D) mentioned above. In this case, as shown in drawing 31, it is on island 144a and 144b, and the mask pattern 201 is formed in the channel field in island 144a and 144b, and the part which counters. And the ion for exfoliation acceleration, for example, a hydrogen ion, is turned and poured into a detached core 120 in the condition. Thereby, hydrogen does not contain to a channel field and transistor characteristics do not deteriorate. In addition, if the ion-implantation process for exfoliation acceleration is completed, a mask pattern 201 will be removed.

[0128] (Process 3) As shown in drawing 10, wrap gate dielectric film 148a and 148b is formed for Islands 144a and 144b with a CVD method.

[0129] The ion-implantation process for exfoliation acceleration can be carried out after the 3rd process (gate dielectric film) as the operation stage (F) besides (A) - (E) mentioned above. In this case, as shown in drawing 32, it is on gate-dielectric-film 148a and 148b, and it is desirable to form a mask pattern 202 in the channel field in island 144a and 144b and the part which counters.

[0130] (Process 4) As shown in drawing 11, the gate electrodes 150a and 150b which consist of polish recon or metal are formed.

[0131] (Process 5) As shown in drawing 12, the mask layer 170 which consists of polyimide etc. is formed, using gate electrode 150b and the mask layer 170 as a mask, it is a self aryne, for example, the ion implantation of boron (B) is performed. Of this, the p+ layers 172a and 172b are formed.

[0132] The ion-implantation process for exfoliation acceleration can be carried out to this boron ion-implantation process and coincidence as that operation stage (G) besides (A) - (F) mentioned above. In this case, the mixed gas of B-2H6(5%)+H2 (95%) is plasma-ized, the boron ion and hydrogen ion which were generated by that cause are accelerated, and it leads to a substrate, without minding a mass spectrograph. If it does so, even if it is the same acceleration voltage, while the boron ion with heavy mass stops at the polycrystalline silicon layer by the side of the upper layer, the hydrogen ion with light mass will be driven in more deeply, and it will reach to a detached core 120.

[0133] In addition, although gate electrode 150b functions as the mask pattern 201 of drawing 31, or the mask pattern 202 of drawing 32 similarly at this time, according to acceleration voltage, a mask layer can be further prepared on gate electrode 150b.

[0134] (Process 6) As shown in drawing 13, the mask layer 174 which consists of polyimide etc. is formed, using gate electrode 150a and the mask layer 174 as a mask, it is a self aryne, for example, the ion implantation of Lynn (P) is performed. Of this, the n+ layers 146a and 146b are formed.

[0135] The ion-implantation process for exfoliation acceleration can be carried out to this Lynn ion-implantation process and coincidence as that operation stage (H) besides (A) - (G) mentioned above. Also in this case, the mixed gas of PH3(5%)+H2 (95%) is plasma-ized, the phosphorus ion and hydrogen ion which were generated by that cause are accelerated, and it leads to a substrate, without minding a mass spectrograph. If it does so, even if it is the same acceleration voltage, while the phosphorus ion with heavy mass stops at the polycrystalline silicon layer by the side of the upper layer, the hydrogen ion with light mass will be driven in more deeply, and it will reach to a detached core 120.

[0136] In addition, although gate electrode 150a functions as the mask pattern 201 of drawing 31, or the mask pattern 202 of drawing 32 similarly in this case, according to acceleration voltage, a mask layer can be further prepared on gate electrode 150a.

[0137] Moreover, although the operation stage (G) of the above-mentioned ion-implantation process for exfoliation acceleration and (H) were simultaneous with the impurity ion-implantation process to the source in a process 5 and a process 6, and a drain field, they may be separately performed before and behind that.

[0138] (Process 7) As shown in drawing 14, an interlayer insulation film 154 is formed and Electrodes 152a-152d are selectively formed after contact hole formation.

[0139] Thus, TFT of the formed CMOS structure corresponds to the transferred layer (thin film device layer) 140 in drawing 2 - drawing 6. In addition, a protective coat may be formed on an interlayer insulation film 154.

[0140] (Process 8) As shown in drawing 15, the epoxy resin layer 160 as a glue line is formed on TFT of a CMOS configuration, next TFT is stuck on the imprint object (for example, soda glass substrate) 180 through the epoxy resin layer 160. Then, heat is applied, an epoxy resin is stiffened and the imprint object 180 and TFT are pasted up (junction).

[0141] In addition, the photopolymer resin which is ultraviolet curing mold adhesives is sufficient as a glue line 160. In this case, ultraviolet rays are irradiated from the imprint object [not heat but] 180 side, and a polymer is stiffened.

[0142] (Process 9) As shown in drawing 16, Xe-Cl excimer laser light is irradiated from the rear face of the translucency substrate 100, for example. This produces and cheats out of exfoliation in the inside of the layer of a detached core 120, and/or an interface.

[0143] (Process 10) A substrate 100 is torn off as shown in drawing 17.

[0144] (Process 11) Finally etching removes a detached core 120. It means that TFT of a CMOS configuration had been imprinted by the imprint object 180 by this as shown in drawing 18.

[0145] <The gestalt of the 2nd operation>, next the gestalt of operation of the 2nd of this invention are explained with reference to drawing 33 - drawing 35. In addition, the gestalt of this 2nd operation imprints twice the transferred layer 140 which consists of thin film device layers, and, in addition to the process of drawing 1 of the gestalt of the 1st operation - drawing 6, the process of drawing 33 - drawing 35 is added.

[0146] Here, with the gestalt of this 2nd operation, the detached core 120 shown in drawing 2 - drawing 5 is called the 1st detached core. Moreover, with the gestalt of this 2nd operation, the glue line 160 of drawing 3 - drawing 6 is called the 2nd detached core. Furthermore, with the gestalt of this 2nd operation, the imprint object 180 of drawing 3 - drawing 6 is called a primary imprint object. Therefore, according to the gestalt of this 2nd operation, in the phase which the process of drawing 6 ended, it means that the transferred layer 140 had been imprinted by the primary imprint object 180 through the 2nd detached core 160.

[0147] With the gestalt of the 2nd operation here, the construction material of the 2nd detached core 160 can use the thing of the same construction material not only as thermofusion nature adhesives and water-soluble adhesives but the 1st detached core 120. In order to make easy exfoliation by this 2nd detached core 160 at this time, the ion implantation which was mentioned above and which was explained with the gestalt of the 1st operation can be performed.

[0148] More nearly hereafter, the additional processing of drawing 33 carried out after the process of drawing 6 - drawing 35 explains 1-3.

[0149] As [additional processing is shown in drawing 33 following the process of 1] drawing 6, the secondary imprint layer 200 is pasted up on the underside (exposed surface) of the thin film device layer 140 through a glue line 190.

[0150] As a suitable example of the adhesives which constitute a glue line 190, various hardening mold adhesives, such as photo-curing mold adhesives, such as reaction hardening mold adhesives, heat-curing mold adhesives, and ultraviolet curing mold adhesives, and aversion hardening mold adhesives, are mentioned. As a presentation of adhesives, what kind of thing is sufficient as an epoxy system, an acrylate system, a silicone system, etc., for example. Formation of such a glue line 190 is made for example, by the applying method.

[0151] After applying hardening mold adhesives to the underside of the transferred layer (thin film device layer) 140 and joining the secondary imprint object 200 further when using said hardening mold adhesives for example, said hardening mold adhesives are stiffened by the hardening approach according to the property of hardening mold adhesives, and the transferred layer (thin film device layer) 140 and the secondary imprint object 200 are pasted up, and it fixes.

[0152] When adhesives are photo-curing molds, light is preferably irradiated from the outside of the secondary imprint object 200 of light transmission nature. As long as it uses as adhesives photo-curing mold adhesives, such as an ultraviolet curing mold which cannot affect a thin film device layer easily, an optical exposure may be carried out from the primary imprint object 180 side of light transmission nature, or primary [of light transmission nature] and the both sides of the secondary imprint object 180,200.

[0153] In addition, unlike a graphic display, a glue line 190 may be formed in the secondary imprint object 200 side, and the transferred layer (thin film device layer) 140 may be pasted up on it. In addition, when secondary imprint object 200 the very thing has an adhesion function, for example, formation of a glue line 190 may be omitted.

[0154] although not limited especially as a secondary imprint object 200 -- a substrate (plate) -- especially a transparency substrate is mentioned. In addition, such a substrate may be monotonous or may be a bow plate.

[0155] Moreover, compared with said substrate 100, properties, such as thermal resistance and corrosion resistance, may be inferior in the secondary imprint object 200. It is because the reason forms the transferred layer (thin film device layer) 140 in a substrate 100 side in this invention, and imprints the transferred layer (thin film device layer) 140 on the secondary imprint object 200 after that, so it does not depend on the temperature conditions in the case of formation of the transferred layer (thin film device layer) 140 etc. for the property required of the secondary imprint object 200, especially thermal resistance. This point is the same also about the primary imprint object 180.

[0156] Therefore, when the maximum temperature in the case of formation of the transferred layer 140 is set to Tmax, a glass transition point (Tg) or softening temperature can use the following [Tmax] as a component of primary and the secondary imprint object 180,200. For example, a glass transition point (Tg) or softening temperature can constitute more preferably primary and 800 degrees C or less of 500 degrees C or less of secondary imprint objects 180,200 from an ingredient 320 degrees C or less still more preferably.

[0157] Moreover, although what has a certain amount of ** (reinforcement) as a mechanical property of primary and the secondary imprint object 180,200 is desirable, you may have flexibility and elasticity.

[0158] As a component of such primary and the secondary imprint object 180,200, various synthetic resin or various glass material are mentioned, and various synthetic resin and the usual cheap (low melting point) glass material are desirable especially.

[0159] As synthetic resin, any of thermoplastics and thermosetting resin are sufficient. For example, polyethylene, a polo propylene, an ethylene-pre pyrene copolymer, Polyolefines, such as an ethylene-vinylacetate copolymer (EVA), annular polyolefine, Denaturation polyolefine, a polyvinyl chloride, a polyvinylidene chloride, polystyrene, A polyamide, polyimide, polyamidoimide, a polycarbonate, Polly (4-methyl BENTEN -1), An ionomer, acrylic resin, polymethylmethacrylate, an acrylic-styrene copolymer (AS resin), Butadiene Styrene, a polio copolymer (EVOH), polyethylene terephthalate (PET), Polyester, such as polyp CHIREN terephthalate (PBT) and PURISHI clo hexane terephthalate (PCT), A polyether, a polyether ketone (PEK), a polyether ether ketone (PEEK), Polyether imide, polyacetal (POM), polyphenylene oxide, Denaturation polyphenylene oxide, polyarylate, aromatic polyester (liquid crystal polymer), Polytetrafluoroethylene, polyvinylidene fluoride, other fluorine system resin, A styrene system, a polyolefine system, a polyvinyl chloride system, a polyurethane system, Various thermoplastic elastomer, such as a fluororubber system and a chlorinated polyethylene system, EBOKISHI resin, phenol resin, a urea resin, melamine resin, unsaturated polyester, The copolymer which is mainly concerned with these, a blend object, a polymer alloy, etc. are mentioned, and silicone resin, polyurethane, etc. can be used combining 1 of sorts of these, and two sorts or more (as a layered product for example, more than two-layer).

[0160] As glass material, silicic-acid glass (quartz glass), silicic-acid alkali glass, soda lime glass, potash lime glass, lead (alkali) glass, barium glass, borosilicate glass, etc. are mentioned, for example. Among these, compared with silicic-acid glass, the melting point is low, and shaping and processing are also comparatively easy the melting point, and, moreover, things other than silicic-acid glass have it, and are

desirable. [cheap]

[0161] When using what consisted of synthetic resin as a secondary imprint object 200, while being able to fabricate the large-scale secondary imprint object 200 in one, even if it is complicated configurations, such as what has a bow side and irregularity, it can manufacture easily, and the various advantages that ingredient cost and a manufacturing cost are also cheap can be enjoyed. Therefore, the activity of synthetic resin is advantageous when manufacturing a large-sized and cheap device (for example, liquid crystal display).

[0162] In addition, the secondary imprint object 200 may constitute some devices like what constitutes the device which became independent in itself like a liquid crystal cell, a light filter and an electrode layer, a dielectric layer, an insulating layer, and a semiconductor device.

[0163] Furthermore, primary and the secondary imprint objects 180,200 may be matter, such as a metal, ceramics, a stone, and timber paper, and may be on the front face of the structures, such as a wall, a column, head lining, and a windowpane, further on the field (up [of the front-face top of the field top of a clock, and an air-conditioner, and a printed circuit board] etc.) of the arbitration which constitutes a certain goods.

[0164] As [additional processing is shown in 2], next drawing 34, thermofusion of the thermofusion nature glue line 160 which is the 2nd detached core is heated and carried out. Consequently, since the adhesive strength of the thermofusion nature glue line 160 becomes weaker, it can be made to secede from the primary imprint object 180 by the thin film device layer 140. In addition, this primary imprint object 180 can be repeated and reused by removing the thermofusion nature adhesives adhering to the primary imprint object 180.

[0165] What is necessary is just to dip preferably the field which contains the 2nd detached core 160 at least in pure water that what is necessary is just to make water contact, when the water-soluble adhesives mentioned above as the 2nd detached core 160 are used. What is necessary is just to contact the field which contains the 2nd detached core 160 at least to an organic solvent, when the organic solvent melting nature adhesives mentioned above as the 2nd detached core 160 are used. the field which contains the 2nd detached core 160 at least when the adhesives which present an exfoliation operation by heating or UV irradiation mentioned above as the 2nd detached core 160 are used -- other layers -- minding -- heating -- or what is necessary is just to carry out UV irradiation Moreover, when an ablation layer is used like the 1st detached core 120 as the 2nd detached core, the 2nd detached core 160 is made to produce an exfoliation phenomenon by optical exposure. That exfoliation is promoted by the effectiveness of impregnation ion at this time.

[0166] As [additional processing is shown in drawing 35 by removing the 2nd detached core 160 which adhered to the front face of the thin film device layer 140 at the 3] last, the thin film device layer 140 imprinted by the secondary imprint object 200 can be obtained. Here, the laminating relation of the thin film device layer 140 to this secondary imprint object 200 becomes the same as the laminating relation of the thin film device layer 140 to the original substrate 100, as shown in drawing 2.

[0167] The imprint to the secondary imprint object 200 of the transferred layer (thin film device layer) 140 is completed through each above process. Then, conductive layers, such as clearance of SiO₂ film which adjoins the transferred layer (thin film device layer) 140, and wiring of a up to [the transferred layer 140], formation of a desired protective coat, etc. can also be performed.

[0168] With the gestalt of the 2nd operation, transferred layer (thin film device layer) 140 the very thing which is an exfoliated object is not exfoliated directly. In order to dissociate in the 1st detached core 120 and the 2nd detached core 160 and to imprint on the secondary imprint object 200, Irrespective of the property of a dissociated object (transferred layer 140), conditions, etc., easily and certainly, it can imprint to homogeneity, there is also no damage to the dissociated object (transferred layer 140) in accordance with separation actuation, and the high dependability of the transferred layer 140 can be maintained.

[0169] If the technique explained with the <gestalt of the 3rd operation> above-mentioned 1st and the gestalt of the 2nd operation is used, the microcomputer constituted using the thin film device as shown in drawing 19 (a), for example can be formed on a desired substrate.

[0170] In drawing 19 (a), the solar battery 340 possessing the PIN junction of an amorphous silicon for supplying the supply voltage of CPU300, RAM320 and the I/O circuits 360 where the thin film device was used and the circuit was constituted, and these circuits is carried on the flexible substrate 182 which consists of plastics etc.

[0171] Since the microcomputer of drawing 19 (a) is formed on the flexible substrate, as shown in drawing 19 (b), since it is lightweight, it has strongly the description that it is strong also to drop in bending.

[0172] The gestalt of <gestalt of the 4th operation> book operation explains the example of the manufacture process in the case of creating the liquid crystal display of the active-matrix mold using a active-matrix substrate as shown in drawing 20 and drawing 21 using the imprint technique of an above-mentioned thin film device.

[0173] (Configuration of a liquid crystal display) As shown in drawing 20, the liquid crystal display of a active-matrix mold possesses the sources 400 of the illumination light, such as a back light, a polarizing plate 420, the active-matrix substrate 440, liquid crystal 460, the opposite substrate 480, and a polarizing plate 500.

[0174] In addition, if it constitutes as a reflective mold liquid crystal panel which replaced with the source 400 of the illumination light, and adopted the reflecting plate when using a flexible substrate like a plastic film for the active-matrix substrate 440 and the opposite substrate 480 of this invention, there is flexibility and a lightweight active matrix liquid crystal panel strong against an impact and can be realized. In addition, when a pixel electrode is formed with a metal, a reflecting plate and a polarizing plate 420 become unnecessary.

[0175] The active-matrix substrate 440 used with the gestalt of this operation arranges TFT in the pixel section 442, and is a driver built-in active-matrix substrate in which the driver circuit (a scanning-line driver and data-line driver) 444 was carried further.

[0176] The sectional view of the important section of this active matrix liquid crystal display is shown in drawing 21, and the circuitry of the important section of a liquid crystal display is shown in drawing 22.

[0177] As shown in drawing 22, the gate is connected to the gate line G1, one side of a source drain is connected to the data line D1, and the pixel section 442 contains TFT (M1) by which another side of a source drain was connected to liquid crystal 460, and liquid crystal 460.

[0178] Moreover, the driver section 444 is constituted including TFT (M2) formed of the same process as TFT (M1) of the pixel section.

[0179] As shown in the left-hand side of drawing 21, TFT (M1) in the pixel section 442 is constituted including the source drain layers 1100a and 1100b, channel 1100e, gate-dielectric-film 1200a, gate electrode 1300a, an insulator layer 1500, and the source drain electrodes 1400a and 1400b.

[0180] In addition, a reference number 1700 is a pixel electrode and a reference number 1702 shows the field (electrical-potential-difference impression field to liquid crystal) where the pixel electrode 1700 impresses an electrical potential difference to liquid crystal 460. The orientation film is omitted among drawing. The pixel electrode 1700 is constituted by metals (in the case of the liquid crystal panel of a reflective mold), such as ITO (in the case of the liquid crystal panel of a light transmission mold), or aluminum. Moreover, in drawing 21, in the electrical-potential-difference impression field 1702 to liquid crystal, although the substrate insulator layer 1000 under the pixel electrode 1700 (interlayer) is removed thoroughly, it is not necessarily limited to this, and since the substrate insulator layer (interlayer) 1000 is thin, when not becoming the hindrance of the electrical-potential-difference impression to liquid crystal, you may leave.

[0181] Moreover, as shown in the right-hand side of drawing 21, TFT (M2) which constitutes the driver section 444 is constituted including the source, the drain layers 1100c and 1100d, channel 1100f, gate-dielectric-film 1200b, gate electrode 1300b, an insulator layer 1500, and the source drain electrodes 1400c and 1400d.

[0182] In addition, in drawing 21, a reference number 480 is for example, an opposite substrate (for example, soda glass substrate), and a reference number 482 is a common electrode. Moreover, a

reference number 1000 is SiO₂ film, a reference number 1600 is an interlayer insulation film (for example, SiO₂ film), and a reference number 1800 is a glue line. Moreover, a reference number 1900 is a substrate (imprint object) which consists for example, of a soda glass substrate.

[0183] (Manufacture process of a liquid crystal display) The manufacture process of the liquid crystal display of drawing 21 is hereafter explained with reference to drawing 23 - drawing 27.

[0184] First, it forms through the same manufacture process as drawing 8 - drawing 18 on the substrate (for example, quartz substrate) 3000 which it is reliable in TFT (M1, M2) like drawing 23, and penetrates laser light, and a protective coat 1600 is constituted. In addition, in drawing 23, a reference number 3100 is a detached core (laser absorption layer) into which the ion for exfoliation acceleration is poured. Moreover, in drawing 23, both TFT(s) (M1, M2) are taken as MOSFET of n mold. However, it is good also as not the thing limited to this but MOSFET of p mold, and CMOS structure.

[0185] Next, as shown in drawing 24, a protective coat 1600 and the substrate insulator layer 1000 are etched selectively, and openings 4000 and 4200 are formed selectively. These two openings are simultaneously formed using a common etching process. In addition, although the substrate insulator layer (interlayer) 1000 is thoroughly removed in opening 4200 in drawing 24, it is not necessarily limited to this, and since the substrate insulator layer (interlayer) 1000 is thin, when not becoming the hindrance of the electrical-potential-difference impression to liquid crystal, you may leave.

[0186] Next, as shown in drawing 25, the pixel electrode 1700 which consists of metals, such as ITO film or aluminum, is formed. In using the ITO film, it becomes the liquid crystal panel of a transparency mold, and in using metals, such as aluminum, it becomes the liquid crystal panel of a reflective mold. Next, as shown in drawing 26, a substrate 1900 is joined through a glue line 1800 (adhesion).

[0187] Next, excimer laser light is irradiated from the rear face of a substrate 3000, the operation by the ion for exfoliation acceleration is also used, and a detached core 120 is made to produce an exfoliation phenomenon, as shown in drawing 26. Then, a substrate 3000 is torn off. Since the force like ** is not required for tearing off at this time, a mechanical damage does not arise in TFT.

[0188] Next, a detached core (laser absorption layer) 3100 is removed. Thereby, the active-matrix substrate 440 as shown in drawing 27 is completed. It has exposed and the electric connection with liquid crystal is possible for the base (field of a reference number 1702) of the pixel electrode 1700. Then, the orientation film is formed in the front face of the insulator layer (interlayers, such as SiO₂) 1000 of the active-matrix substrate 440, and pixel electrode 1702 front face, and orientation processing is performed. The orientation film is omitted in drawing 27.

[0189] And the pixel electrode 1709 and the common electrode which counters are further formed in the front face, the opposite substrate 480 and the active MATORIKU substrate 440 of drawing 21 with which orientation processing of the front face was carried out are closed with a sealing agent (sealant), liquid crystal is enclosed among both substrates, and a liquid crystal display as shown in drawing 21 is completed.

[0190] The gestalt of operation of the 5th of this invention is shown in <gestalt of the 5th operation> drawing 28.

[0191] With the gestalt of this operation, multiple-times activation of the imprint approach of an above-mentioned thin film device is carried out, on a larger substrate (imprint object) than the substrate of an imprinting agency, two or more patterns containing a thin film device are imprinted, and a large-scale active-matrix substrate is formed eventually.

[0192] That is, on the big substrate 7000, the imprint of multiple times is performed and the pixel sections 7100a-7100P are formed. TFT and wiring are formed in the pixel section as surrounded and shown to the drawing 28 upside by the alternate long and short dash line. In drawing 28, a reference number 7210 is the scanning line, a reference number 7200 is a signal line and a reference number 7230 is [a reference number 7220 is a gate electrode and] a pixel electrode.

[0193] The large-scale active-matrix substrate carrying a reliable thin film device can be created by repeating and using a reliable substrate or carrying out multiple-times activation of the imprint of a thin film pattern using two or more 1st substrates.

[0194] The gestalt of operation of the 6th of <gestalt of the 6th operation> this invention is shown in

drawing 29 .

[0195] The description of the gestalt of this operation is imprinting two or more patterns containing the thin film device (that is, thin film device with which minimum line width's differs) with which multiple-times activation of the imprint approach of an above-mentioned thin film device is carried out, and design rules' (that is, design rule's when carrying out a pattern design's) differ on a bigger substrate than the substrate top of an imprinting agency.

[0196] In drawing 29 , the driver circuit (8000-8032) created in the more detailed manufacture process rather than the pixel section (7100a-7100p) is created around the substrate 6000 by the imprint of multiple times in the active-matrix substrate of driver loading.

[0197] Since the shift register which constitutes a driver circuit carries out actuation of a logic level to the bottom of a low battery, rather than Pixel TFT, pressure-proofing may be low, and as it is therefore set to TFT more detailed than Pixel TFT, high integration can be attained.

[0198] According to the gestalt of this operation, two or more circuits where design rule level differs (that is, manufacture processes differ) are realizable on one substrate. In addition, since high pressure-proofing is the need like Pixel TFT, a sampling means (thin film transistor M2 of drawing 22) to sample a data signal by control of a shift register may be formed with the same process as Pixel TFT / same design rule.

[0199]

[Example] Next, the concrete example of this invention is explained.

[0200] (Example 1) The quartz substrate (1630 degrees C, a strain point: softening temperature : 1070 degrees C, permeability of excimer laser : about 100%) with a 50mm[50mm by] x thickness of 1.1mm was prepared, and the amorphous silicon (a-Si) film was formed in one side of this quartz substrate as a detached core (laser beam absorption layer) with the low voltage CVD method (Si₂H₆ gas, 425 degrees C). The thickness of a detached core was 100nm.

[0201] Next, it is SiO₂ as an interlayer on a detached core. The film was formed with the ECR-CVD method (SiH₄+O₂ gas, 100 degrees C). An interlayer's thickness was 200nm.

[0202] Next, the amorphous silicon film of 50nm of thickness was formed as a transferred layer on the interlayer with the low voltage CVD method (Si₂H₆ gas, 425 degrees C), a laser beam (wavelength of 308nm) is irradiated, this amorphous silicon film was crystallized, and it considered as the polish recon film. Then, to this polish recon film, predetermined pattern NINGU was given and the field used as the source drain channel of a thin film transistor was formed. then, a TEOS-CVD method (SiH₄+O₂ gas) -- 1200nm gate dielectric film SiO₂ after forming, form a gate electrode (structure where laminating formation of the refractory metals, such as Mo, was carried out at polish recon), on gate dielectric film, and it carries out an ion implantation, using a gate electrode as a mask -- self align ---like (selfer line) -- the source drain field was formed and the thin film transistor was formed. At this time, the hydrogen ion was poured into coincidence at the detached core. Then, the electrode connected to a source drain field and wiring, and wiring which leads to a gate electrode are formed if needed. Although aluminum is used for these electrodes and wiring, it is not limited to this. Moreover, when worrying about melting of aluminum by the laser radiation of an after process, a high-melting metal (what is not fused by the laser radiation of an after process) may be used rather than aluminum.

[0203] Next, ultraviolet curing mold adhesives were applied on said thin film transistor (thickness: 100 micrometers), further, after joining a transparent large-sized glass substrate (soda glass, softening-temperature: 740 degree C, a strain point: 511 degrees C) with a 300mm[200mm by] x thickness of 1.1mm to the paint film as an imprint object, ultraviolet rays were irradiated from the glass substrate side, adhesives were stiffened, and adhesion immobilization of these was carried out.

[0204] Next, Xe-Cl excimer laser (wavelength: 308nm) was irradiated from the quartz substrate side, and the detached core was made to produce exfoliation (exfoliation in a layer, and interfacial peeling) by carrying out the beam scan shown after drawing 31 . The irradiated energy density of Xe-Cl excimer laser was 250 mJ/cm², and irradiation time was 20ns. In addition, the exposure of excimer laser had a spot beam exposure and a line beam exposure, and when it was a spot beam exposure, the spot exposure was carried out to the predetermined unit field (for example, 8mmx8mm), and it irradiated this spot

exposure, carrying out a beam scan so that the exposure field of each time may not lap (it does not lap all around like). Moreover, in the line beam exposure, it irradiated, carrying out the beam scan of the predetermined unit field (for example, 378mmx0.1mm and 378mmx0.3mm (field where, as for these, 90% or more of energy is obtained)) similarly, so that the exposure field of each time may not lap.

[0205] Then, the quartz substrate and the glass substrate (imprint object) were torn off in the detached core, and the thin film transistor and interlayer who were formed on the quartz substrate were imprinted to the glass substrate side.

[0206] Then, etching, washing, or those combination removed the detached core adhering to the front face of the middle class by the side of a glass substrate. Moreover, processing with the same said of a quartz substrate was performed, and the reuse was presented.

[0207] In addition, if the glass substrate used as an imprint object is a bigger substrate than a quartz substrate, the imprint to a glass substrate from a quartz substrate like this example can be repeatedly carried out to a superficially different field, and many thin film transistors can be formed on a glass substrate from the number of the thin film transistors which can be formed in a quartz substrate. Furthermore, on a glass substrate, a laminating can be carried out repeatedly and more thin film transistors can be formed similarly.

[0208] (Example 2) a detached core -- a separation stratification process -- H (hydrogen) -- 20at(s)% -- the thin film transistor was imprinted like the example 1 except having considered as the amorphous silicon film to contain.

[0209] In addition, adjustment of the amount of H in the amorphous silicon film was performed by setting up suitably the conditions at the time of membrane formation by the low voltage CVD method.

[0210] (Example 3) The thin film transistor was imprinted like the example 1 except having used the detached core as the ceramic thin film (presentation-bTiO₃, thickness: 200nm) formed with the sol-gel method with the spin coat.

[0211] (Example 4) The thin film transistor was imprinted like the example 1 except having used the detached core as the ceramic thin film (presentation: BaTiO₃, thickness:400nm) formed by sputtering.

[0212] (Example 5) The thin film transistor was imprinted like the example 1 except having used the detached core as the ceramic thin film (presentation :P b (Zr Ti)O₃ (PZT) and thickness: 50nm) formed by the laser-ablation method.

[0213] (Example 6) The thin film transistor was imprinted like the example 1 except having used the detached core as the polyimide film (thickness: 200nm) formed with the spin coat.

[0214] (Example 7) The thin film transistor was imprinted like the example 1 except having used the detached core as the polyphenylene sulfide film (thickness: 200nm) formed with the spin coat.

[0215] (Example 8) The thin film transistor was imprinted like the example 1 except having used the detached core as aluminum layer (thickness: 300nm) formed by sputtering.

[0216] (Example 9) As an exposure light, the thin film transistor was imprinted like the example 2 except having used Kr-F excimer laser (wavelength: 248nm). In addition, the energy density of the irradiated laser was 250 mJ/cm², and irradiation time was 20ns.

[0217] (Example 10) As an exposure light, the thin film transistor was imprinted like the example 2 except having used Nd-YAIG laser (wavelength: 1068nm). In addition, the energy density of the irradiated laser was 400 mJ/cm², and irradiation time was 20ns.

[0218] (Example 11) The thin film transistor was imprinted like the example 1 except having considered as the thin film transistor of the polish recon film (80nm of thickness) by elevated-temperature process 1000 degree C as a transferred layer.

[0219] (Example 12) As an imprint object, the thin film transistor was imprinted like the example 1 except having used the transparency substrate made from a polycarbonate (glass transition point: 130 degrees C).

[0220] (Example 13) As an imprint object, the thin film transistor was imprinted like the example 2 except having used the transparency substrate made of an AS resin (glass transition point: 70-90 degrees C).

[0221] (Example 14) As an imprint object, the thin film transistor was imprinted like the example 3

except having used the transparency substrate made from polymethylmethacrylate (glass transition point: 70-90 degrees C).

[0222] (Example 15) As an imprint object, the thin film transistor was imprinted like the example 5 except having used the transparency substrate made from polyethylene terephthalate (glass transition point: 67 degrees C).

[0223] (Example 16) As an imprint object, the thin film transistor was imprinted like the example 6 except having used the transparency substrate made from high density polyethylene (glass transition point: 77-90 degrees C).

(Example 17) As an imprint object, the thin film transistor was imprinted like the example 9 except having used the transparency substrate made from a polyamide (glass transition point: 145 degrees C).

[0224] (Example 18) As an imprint object, the thin film transistor was imprinted like the example 10 except having used the transparency substrate made of an epoxy resin (glass transition point: 120 degrees C).

[0225] (Example 19) As an imprint object, the thin film transistor was imprinted like the example 11 except having used the transparency substrate made from polymethylmethacrylate (glass transition point: 70-90 degrees C).

[0226] About examples 1-19, when the condition of the imprinted thin film transistor was guessed the ** view under the naked eye and the microscope, respectively, all had neither a defect nor nonuniformity and the imprint was made by homogeneity.

[0227] As stated above, when using the imprint technique of this invention, it was able to become possible to imprint a thin film device (transferred layer) to various imprint objects, especially exfoliation of a substrate required for an imprint was able to be performed reasonable, without acting too much force. or [that a thin film cannot be formed directly by this] -- or it can be formed by imprint also to what consisted of an ingredient unsuitable for forming, an ingredient with easy shaping, a cheap ingredient, etc., the large-sized body which is hard to move.

[0228] That in which properties, such as thermal resistance and corrosion resistance, are inferior compared with various synthetic resin or a substrate ingredient like glass material with the low melting point can be used especially for an imprint object. therefore -- for example, it can face manufacturing the liquid crystal display in which the thin film transistor (especially poly-Si TFT) was formed on the transparency substrate, and a large-sized and cheap liquid crystal display can be easily manufactured now as an imprint object as a substrate using the quartz-glass substrate which is excellent in thermal resistance by using a transparency substrate of the ingredient which it is cheap and processing tends to carry out like glass material with low various synthetic resin and melting point. Such an advantage is the same also about manufacture of not only a liquid crystal display but other devices.

[0229] Moreover, although the above advantages are enjoyed, since a transferred layer like a functional thin film can be formed to a heat-resistant high substrate like a reliable substrate, especially a quartz-glass substrate and patterning can be carried out further, a reliable functional thin film can be formed on an imprint object irrespective of the material property of an imprint object.

[0230] Moreover, although such a reliable substrate is expensive, it is also possible to reuse it and, therefore, a manufacturing cost is also reduced.

[0231]

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the sectional view showing the 1st process in the gestalt of implementation of the 1st of the imprint approach of the thin film device of this invention.

[Drawing 2] It is the sectional view showing the 2nd process in the gestalt of implementation of the 1st of the imprint approach of the thin film device of this invention.

[Drawing 3] It is the sectional view showing the 3rd process in the gestalt of implementation of the 1st of the imprint approach of the thin film device of this invention.

[Drawing 4] It is the sectional view showing the 4th process in the gestalt of implementation of the 1st of the imprint approach of the thin film device of this invention.

[Drawing 5] It is the sectional view showing the 5th process in the gestalt of implementation of the 1st of the imprint approach of the thin film device of this invention.

[Drawing 6] It is the sectional view showing the 6th process in the gestalt of implementation of the 1st of the imprint approach of the thin film device of this invention.

[Drawing 7] It is drawing showing change of the permeability to the wavelength of the laser light of the 1st substrate (substrate 100 of drawing 1).

[Drawing 8] It is the sectional view showing the 1st process for forming the thin film device of drawing 2.

[Drawing 9] It is the sectional view showing the 2nd process for forming the thin film device of drawing 2.

[Drawing 10] It is the sectional view showing the 3rd process for forming the thin film device of drawing 2.

[Drawing 11] It is the sectional view showing the 4th process for forming the thin film device of drawing 2.

[Drawing 12] It is the sectional view showing the 5th process for forming the thin film device of drawing 2.

[Drawing 13] It is the sectional view showing the 6th process for forming the thin film device of drawing 2.

[Drawing 14] It is the sectional view showing the 7th process for forming the thin film device of drawing 2.

[Drawing 15] It is a sectional view to show the process shown in drawing 3 in a detail.

[Drawing 16] It is a sectional view to show the detail of the process shown in drawing 4.

[Drawing 17] It is a sectional view to show the detail of the process shown in drawing 5.

[Drawing 18] It is a sectional view to show the detail of the process shown in drawing 6.

[Drawing 19] (a) and (b) are both the perspective views of the microcomputer manufactured using this invention.

[Drawing 20] It is drawing for explaining the configuration of a liquid crystal display.

[Drawing 21] It is drawing showing the cross-section structure of the important section of a liquid crystal display.

[Drawing 22] It is drawing for explaining the configuration of the important section of a liquid crystal display.

[Drawing 23] It is the sectional view of the device in which the 1st process of the manufacture approach of the active-matrix substrate using this invention is shown.

[Drawing 24] It is the sectional view of the device in which the 2nd process of the manufacture approach of the active-matrix substrate using this invention is shown.

[Drawing 25] It is the sectional view of the device in which the 3rd process of the manufacture approach of the active-matrix substrate using this invention is shown.

[Drawing 26] It is the sectional view of the device in which the 4th process of the manufacture approach of the active-matrix substrate using this invention is shown.

[Drawing 27] It is the sectional view of the device in which the 5th process of the manufacture approach of the active-matrix substrate using this invention is shown.

[Drawing 28] It is drawing of a ***** sake about other examples of the imprint approach of the thin film device of this invention.

[Drawing 29] It is drawing of a ***** sake about the example of further others of the imprint approach of the thin film device of this invention.

[Drawing 30] It is drawing of a ***** sake about the modification of the imprint approach of the thin film device of this invention.

[Drawing 31] It is the sectional view showing the impregnation process of the ion for exfoliation acceleration carried out after the process of drawing 9.

[Drawing 32] It is the sectional view showing the impregnation process of the ion for exfoliation acceleration carried out after the process of drawing 10.

[Drawing 33] The additional processing at the time of the 2 times imprint performed by continuing at the process of drawing 6 is the outline sectional view showing 1.

[Drawing 34] The additional processing at the time of the 2 times imprint performed by continuing at the process of drawing 33 is the outline sectional view showing 2.

[Drawing 35] The additional processing at the time of the 2 times imprint performed by continuing at the process of drawing 34 is the outline sectional view showing 3.

[Description of Notations]

100 Substrate

120 Detached Core

140 Thin Film Device Layer

160 Glue Line

180 Imprint Object

[Translation done.]

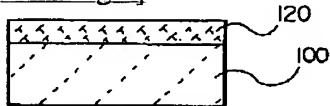
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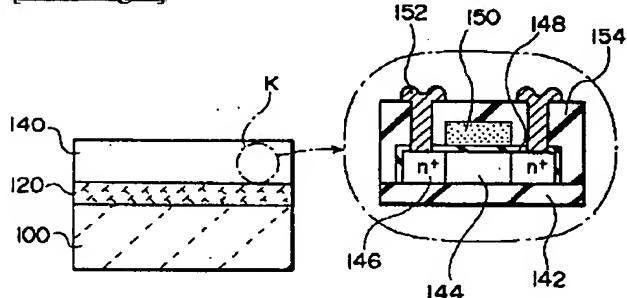
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DRAWINGS

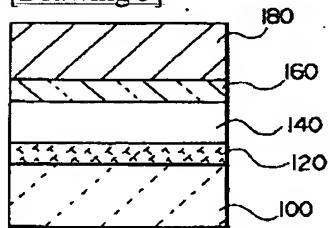
[Drawing 1]



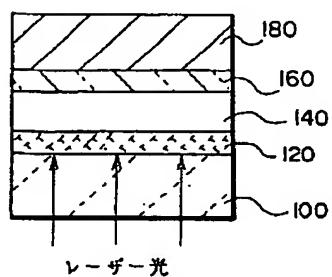
[Drawing 2]



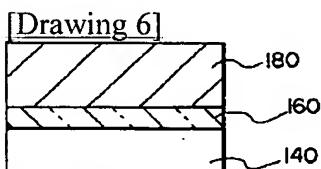
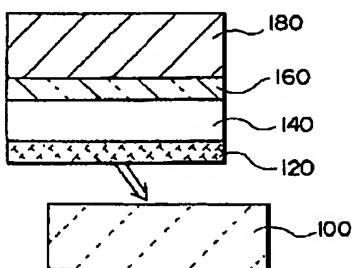
[Drawing 3]



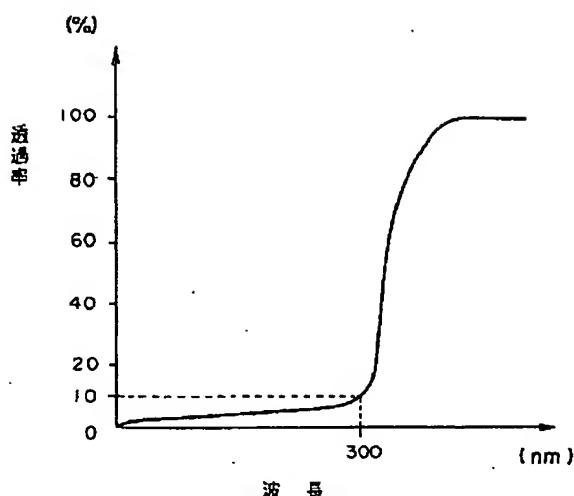
[Drawing 4]



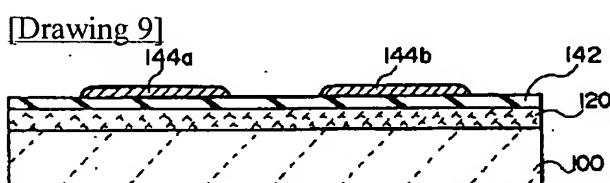
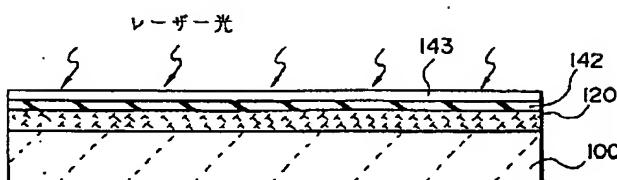
[Drawing 5]



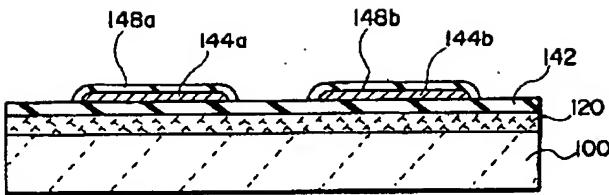
[Drawing 7]



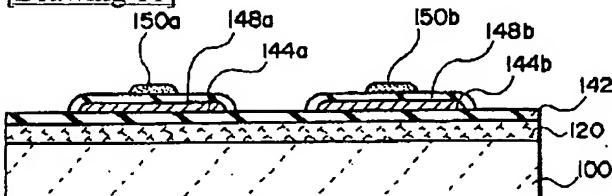
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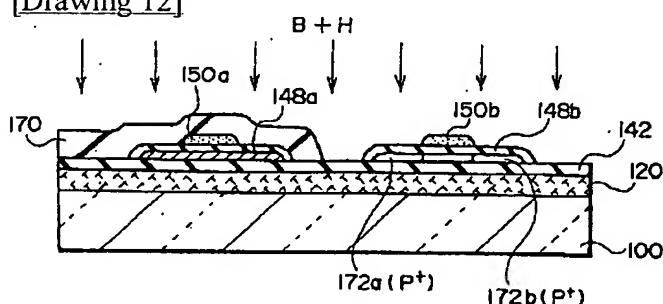
[Drawing 10]



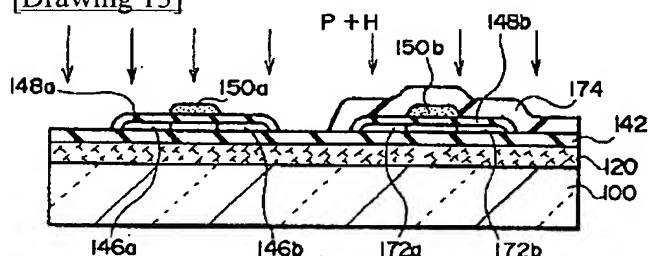
[Drawing 11]



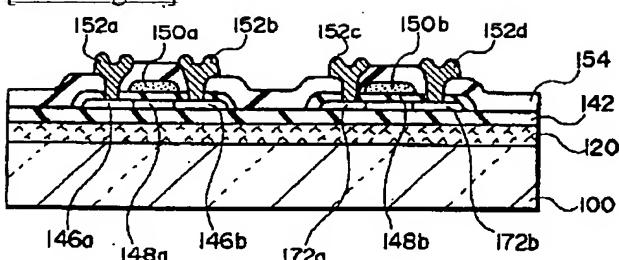
[Drawing 12]



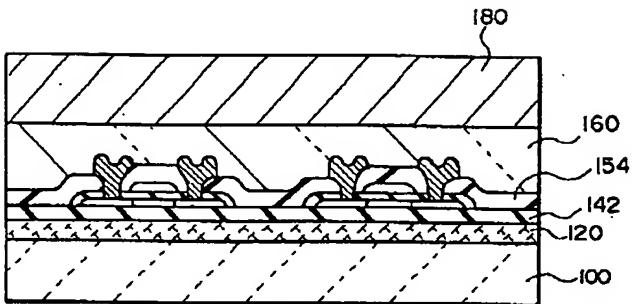
[Drawing 13]



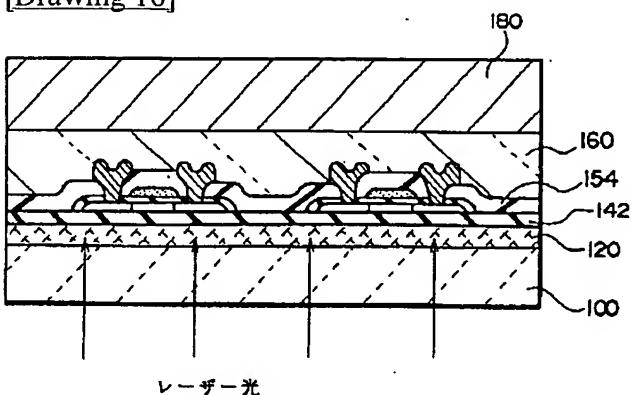
[Drawing 14]



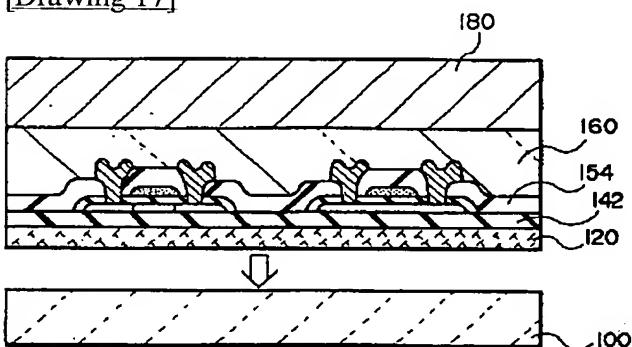
[Drawing 15]



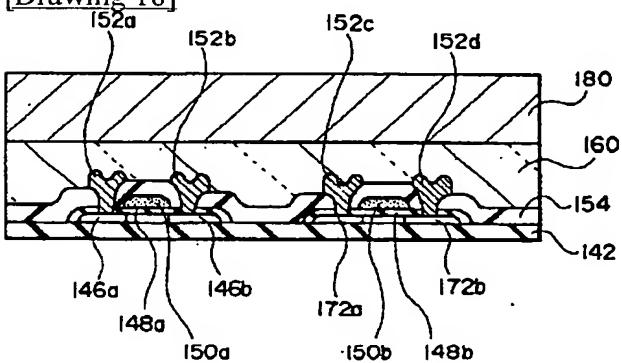
[Drawing 16]



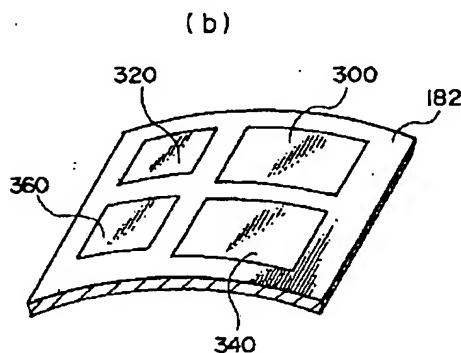
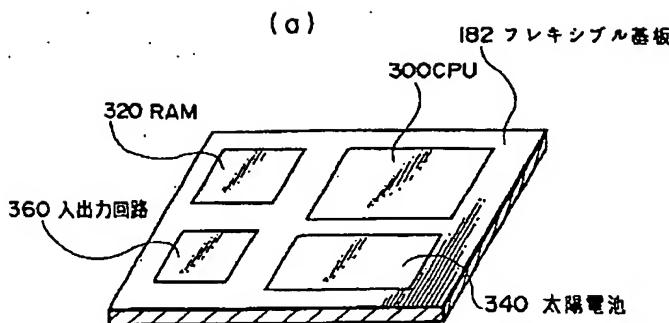
[Drawing 17]



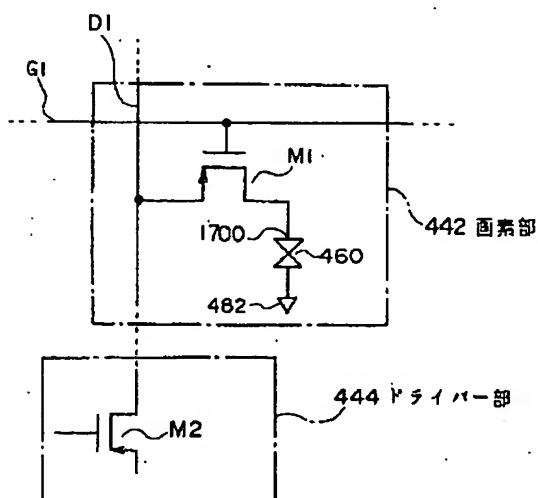
[Drawing 18]



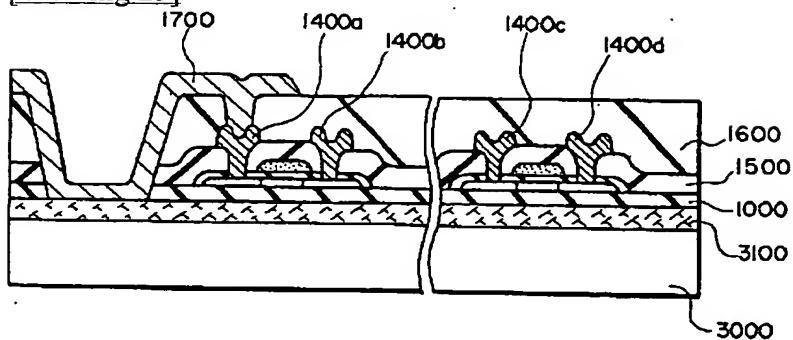
[Drawing 19]



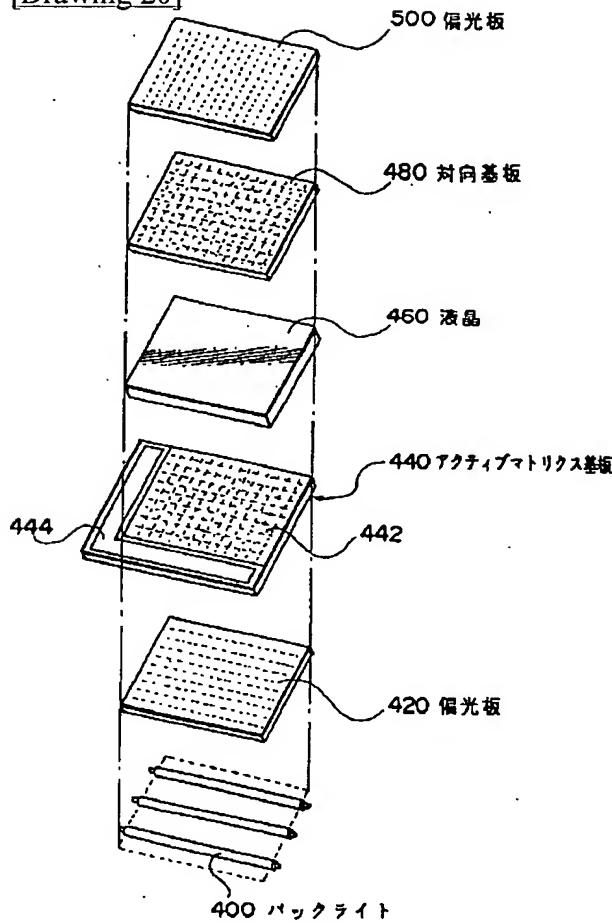
[Drawing 22]



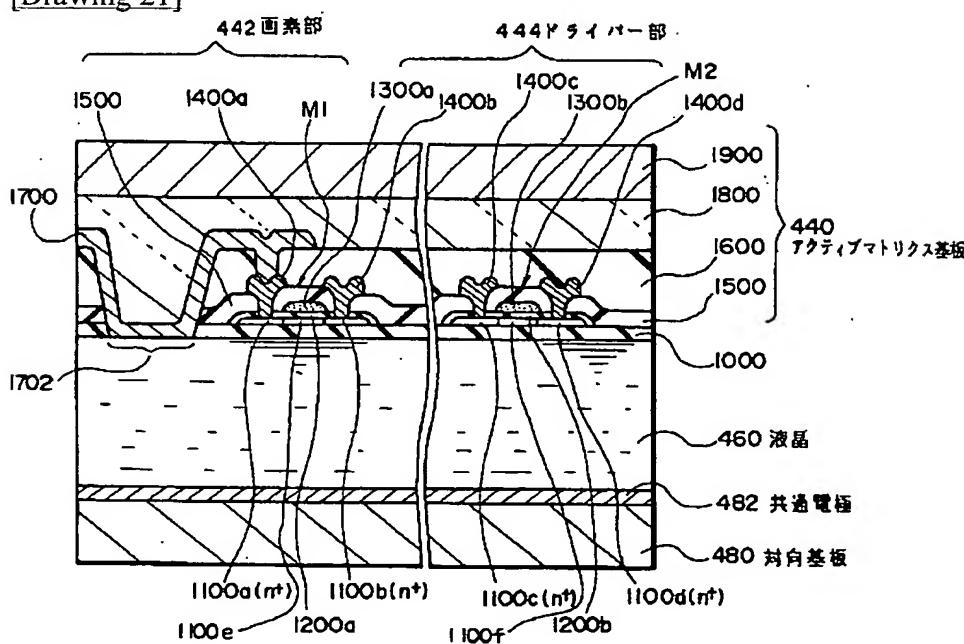
[Drawing 25]



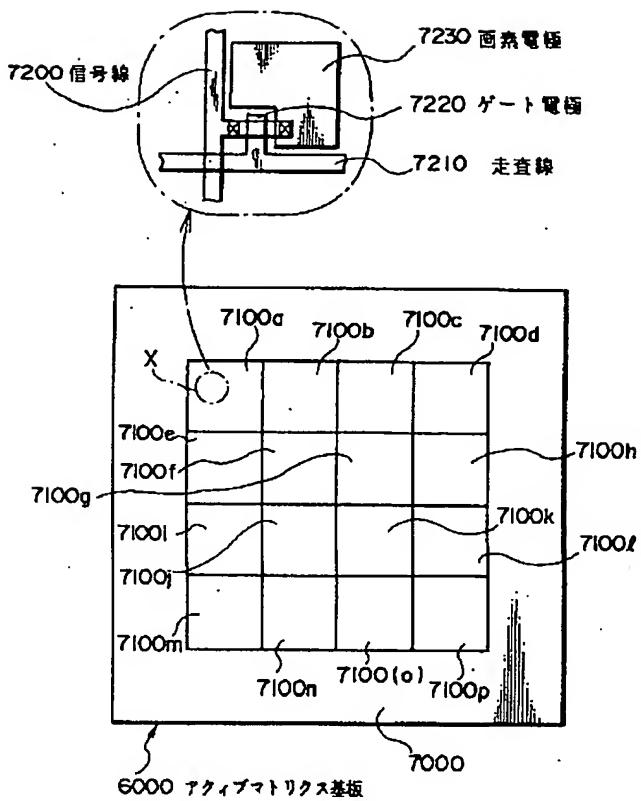
[Drawing 20]



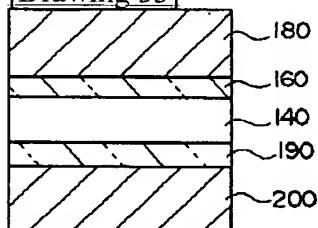
[Drawing 21]



[Drawing 28]



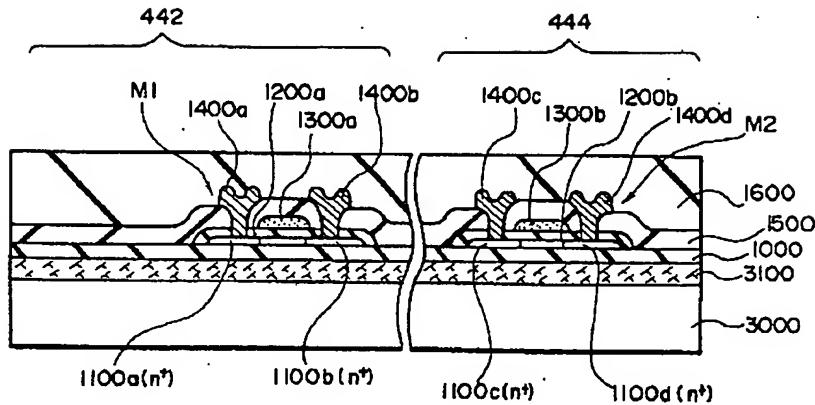
[Drawing 33]



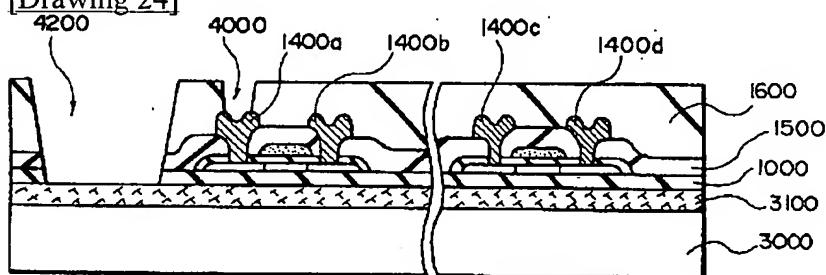
[Drawing 35]



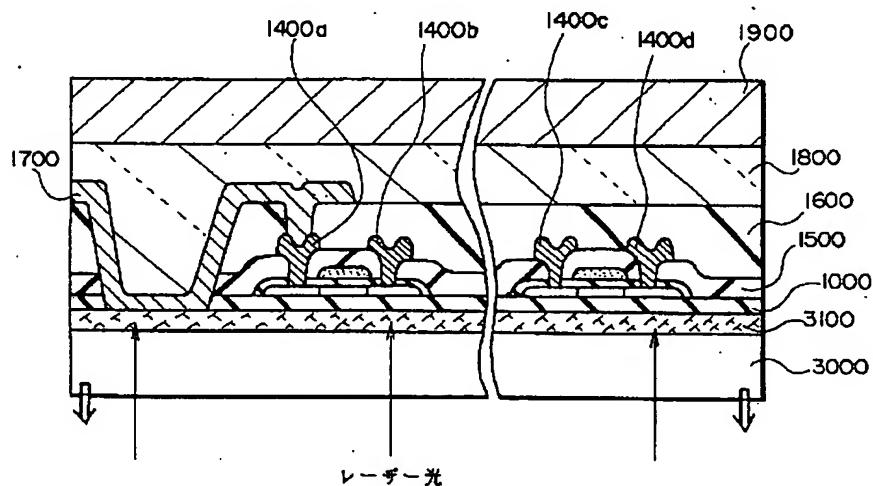
[Drawing 23]



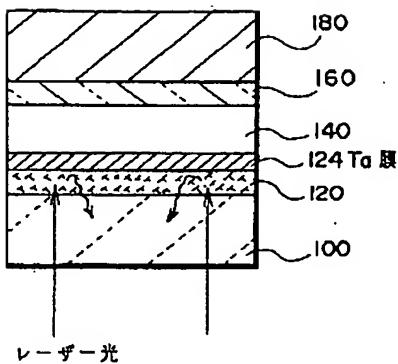
[Drawing 24]



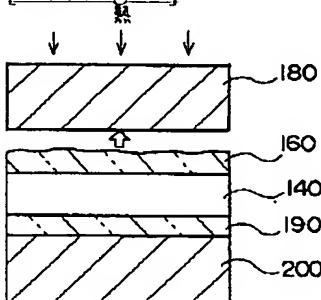
[Drawing 26]



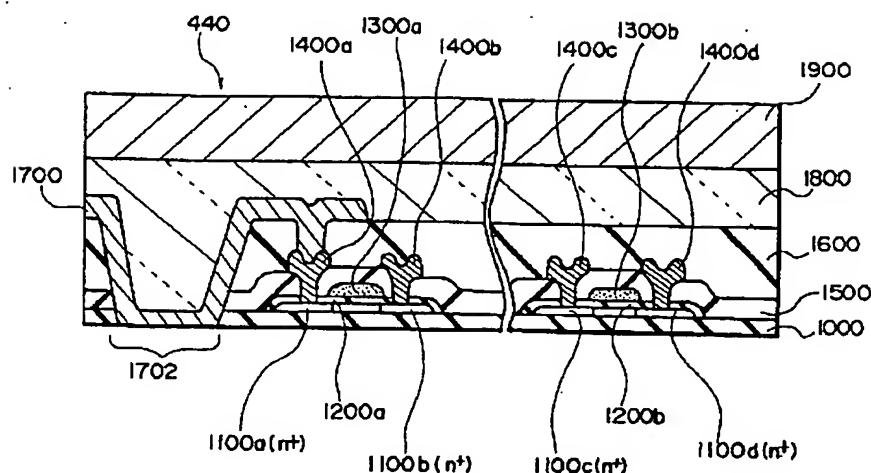
[Drawing 30]



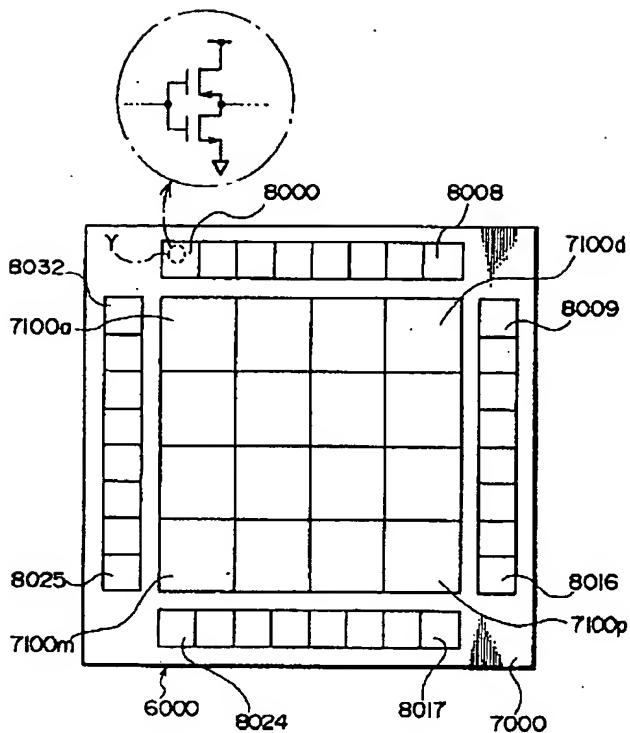
[Drawing 34]



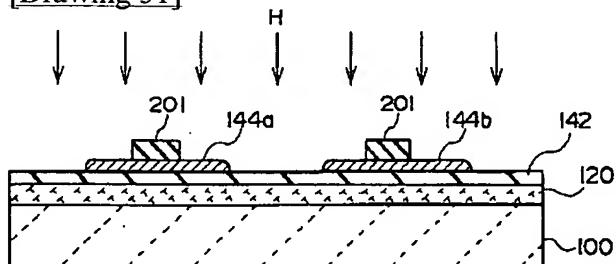
[Drawing 27]



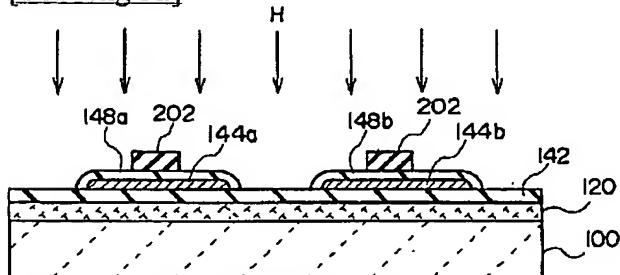
[Drawing 29]



[Drawing 31]



[Drawing 32]



[Translation done.]

PATENT ABSTRACTS OF JAPAN

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(71)Applicant : SEIKO EPSON CORP

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(72)Inventor : INOUE SATOSHI
SHIMODA TATSUYA

(30)Priority

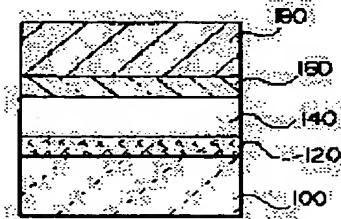
Priority number : 10 60594 Priority date : 25.02.1998 Priority country : JP

(54) THIN-FILM EXFOLIATION METHOD, THIN-FILM DEVICE TRANSFER METHOD, THIN-FILM DEVICE, ACTIVE MATRIX SUBSTRATE AND LIQUID CRYSTAL DISPLAYING DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a method, with which a thin-film device formed on a substrate can be exfoliated easily from the substrate.

SOLUTION: An isolation layer 120 is provided on a substrate 100, and a thin-film device 140 such as a TFT, etc., is formed thereon. Exfoliation accelerating ions such as hydrogen ions, for example, are injected into the isolated region 120, in the middle of the formation of the thin film device 140. After the thin-film device 140 has been formed, the thin-film device 140 is connected to a transfer member 180 via a bonded layer 160, and then a laser beam is made to irradiate from the side of the substrate. As a result, the isolation layer 120 is exfoliated, taking advantage of the action of the exfoliation acceleration ions. The thin film device 140 is made to exfoliate from the substrate 100. As a result, the desired thin-film device can be transferred to any type of substrate.



LEGAL STATUS

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[Date of registration]

[Number of appeal against examiner's decision
of rejection]

[Date of requesting appeal against examiner's
decision of rejection]

[Date of extinction of right]

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CLAIMS

[Claim(s)]

[Claim 1] The 1st process which forms a detached core on a substrate, and the 2nd process which forms a thin film device on said detached core, The 3rd process which produces an exfoliation phenomenon in the inside of the layer of said detached core, and/or an interface, and makes said substrate exfoliate from said detached core, The exfoliation approach of the thin film device which is the exfoliation approach of a thin film device of ****(ing), and is characterized by preparing like ion grouting which pours ion into said detached core before said 3rd process.

[Claim 2] The exfoliation approach of the thin film device characterized by including the process which makes said ion poured into said detached core gasificate at said three processes in claim 1.

[Claim 3] It is the exfoliation approach of the thin film device characterized by including the process in which said 3rd process carries out an optical exposure in claim 2 at an account detached core.

[Claim 4] The exfoliation approach of the thin film device characterized by cutting association of the atom or molecule which constitutes said detached core like said ion grouting with said ion in claim 1 thru/or either of 3, and giving a damage beforehand to said detached core.

[Claim 5] The exfoliation approach of the thin film device characterized by changing the property of said detached core with said ion, and weakening the adhesion of said detached core and said substrate beforehand like said ion grouting in claim 1 thru/or either of 4.

[Claim 6] It is the exfoliation approach of the thin film device which said 2nd process has a thin film transistor formation process for forming a thin film transistor in claim 1 thru/or either of 5, and is characterized by carrying out said thin film transistor formation process after said channel layer formation process like said ion grouting including a channel layer formation process.

[Claim 7] It is the exfoliation approach of the thin film device characterized by carrying out said thin film transistor formation process after said channel pattern formation process like said ion grouting in claim 6 including a channel pattern formation process after said channel layer formation process.

[Claim 8] It is the exfoliation approach of the thin film device characterized by forming a mask among said channel layers like said ion grouting in claims 6 or 7 on a channel field and the becoming field, and carrying out.

[Claim 9] It is the exfoliation approach of the thin film device characterized by being the process in which said thin film transistor formation process forms gate dielectric film on this channel pattern after said channel pattern formation process in claim 7, and on this gate dielectric film, and carrying out like said ion grouting by using said gate electrode as a mask including said channel field and the process which forms a gate electrode in the field which counters.

[Claim 10] It is the exfoliation approach of the thin film device characterized by pouring into coincidence the impurity ion driven into either [at least] the source field in said channel pattern, or a drain field like said ion grouting in claims 8 or 9, and said ion which mass is lighter than it and is driven into said detached core.

[Claim 11] Like said ion grouting, it is the exfoliation approach of the thin film device characterized by carrying out in front of said crystallization process including the crystallization

process which said thin film transistor formation process carries out laser annealing of the process which forms an amorphous silicon layer as said channel layer, and its account amorphous silicon layer of back to front in claim 6, and is crystallized.

[Claim 12] It is the exfoliation approach of the thin film device characterized by said ion being a hydrogen ion in claim 1 thru/or either of 11.

[Claim 13] The exfoliation approach of the thin film device characterized by making into less than 350 degrees C process temperature of the process at which said ion grouting is carried out behind in claim 12.

[Claim 14] The thin film device which uses the exfoliation approach of ** for claim 1 thru/or either of 13, exfoliates from said substrate, and changes.

[Claim 15] The active-matrix substrate which is a active-matrix substrate with which the pixel section is constituted including the thin film transistor arranged in the shape of a matrix, and the pixel electrode connected to the end of the thin film transistor, and was manufactured by imprinting the thin film transistor of said pixel section using an approach according to claim 6 to 13.

[Claim 16] The liquid crystal display manufactured using the active-matrix substrate according to claim 15.

[Claim 17] The 1st process which forms the 1st detached core on a substrate, and the 2nd process which forms the transferred layer containing a thin film device on said 1st detached core, The 3rd process which forms the 2nd detached core which consists of water solubility or organic solvent melting nature adhesives on said transferred layer, It borders on said 1st detached core at the 4th process which joins a primary imprint object on said 2nd detached core. The 5th process which removes said substrate from said transferred layer, and the 6th process which joins a secondary imprint object to the inferior surface of tongue of said transferred layer, The imprint approach of the thin film device characterized by imprinting said transferred layer which said 2nd detached core is contacted to water or an organic solvent, has the 7th process which removes said primary imprint object from said transferred layer bordering on said 2nd detached core, and contains said thin film device on a secondary imprint object.

[Claim 18] The 1st process which forms the 1st detached core on a substrate, and the 2nd process which forms the transferred layer containing a thin film device on said 1st detached core, The 3rd process which forms the 2nd detached core which consists of the adhesives which have an exfoliation operation by heating or UV irradiation on said transferred layer, It borders on said 1st detached core at the 4th process which joins a primary imprint object on said 2nd detached core. The 5th process which removes said substrate from said transferred layer, and the 6th process which joins a secondary imprint object to the inferior surface of tongue of said transferred layer, The imprint approach of the thin film device characterized by imprinting said transferred layer which carries out UV irradiation, has heating or the 7th process which removes said primary imprint object from said transferred layer bordering on said 2nd detached core for said 2nd detached core, and contains said thin film device on a secondary imprint object.

[Translation done.]

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3. In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the exfoliation approach of a thin film device, the imprint approach of a thin film device, a thin film device, a active-matrix substrate, and a liquid crystal display.

[0002]

[Background of the Invention] For example, it faces manufacturing the liquid crystal display using a thin film transistor (TFT), and passes through the process which forms a thin film transistor by CVD etc. on a substrate. Since the process which forms a thin film transistor on a substrate is accompanied by high temperature processing, a substrate needs to use what has the high thing, i.e., the softening temperature, and the high melting point of the quality of the material which is excellent in thermal resistance. Therefore, in current, quartz glass is used as a substrate which bears the temperature of about 1000 degrees C, and heat-resisting glass is used as a substrate which bears the temperature around 500 degrees C.

[0003] As mentioned above, the substrate carrying a thin film device must satisfy the conditions for manufacturing those thin film devices. That is, it is determined that the substrate to be used will surely fulfill the manufacture conditions of the device carried.

[0004] However, when its attention is paid only to the phase after the substrate carrying thin film devices, such as TFT, is completed, above-mentioned "substrate" is not sometimes necessarily desirable.

[0005] For example, although a quartz substrate, a heat-resisting glass substrate, etc. are used as mentioned above when passing through the manufacture process accompanied by high temperature processing, these are very expensive, therefore cause the rise of a product price.

[0006] Moreover, a glass substrate has the property for it to be heavy and to be easy to be divided. Although what cannot break easily even if it is cheap as much as possible, it is light and it bears and drops also on deformation of some with the liquid crystal display used for portable electronic devices, such as a palmtop computer and a portable telephone, is desirable, actually, a glass substrate is heavy, and is weak to deformation, and it is common that there is fear of destruction by fall.

[0007] That is, it was very difficult for a slot to be between the desirable properties required of the constraint which comes from manufacture conditions, and a product, and to satisfy the conditions and property of these both sides to it.

[0008] Then, an applicant for this patent has proposed the technique of exfoliating from the 1st substrate and making the 2nd substrate imprinting this thin film device, after forming a thin film device on the 1st substrate in the conventional process (Japanese Patent Application No. No. 225643 [eight to]). For this reason, the detached core is formed between the 1st substrate and the thin film device which is a transferred layer. The thin film device which is a transferred layer is made to exfoliate from the 1st substrate, and this transferred layer is made to imprint to a 2nd substrate side by irradiating light at this detached core.

[0009]

[Problem(s) to be Solved by the Invention] According to the experiment of this invention person,

when making a thin film device exfoliate from the 1st substrate, it was discovered that an exfoliation phenomenon may not fully arise in a detached core only by irradiating light at a detached core.

[0010] And it became clear that it was [of this invention person] dependent on the property of a detached core wholeheartedly whether it is easy to produce this exfoliation phenomenon according to research.

[0011] Furthermore, the technical problem that it will differ mutually had the laminating relation of the transferred layer to the 1st substrate used when manufacturing a transferred layer, and the laminating relation of the transferred layer to the 2nd substrate which is the imprint place of the transferred layer.

[0012] Then, this invention is to offer the thin film device, active-matrix substrate, and liquid crystal display which use it for the exfoliation approach list of a thin film device compensate [list] that it will be in the condition that a detached core tends to exfoliate, and it was made to make a thin film device exfoliate easily from a substrate, and are manufactured in front of the process which makes a detached core produce an exfoliation phenomenon in exfoliation.

[0013] Other purposes of this invention are to offer the imprint approach of the thin film device which can make in agreement the laminating relation of the transferred layer to the substrate used at the time of manufacture of a transferred layer, and the laminating relation of the transferred layer to the imprint object which is the imprint place of the transferred layer.

[0014]

[Means for Solving the Problem] The 1st process at which invention according to claim 1 forms a detached core on a substrate, and the 2nd process which forms a thin film device on said detached core, An exfoliation phenomenon is produced in the inside of the layer of said detached core, and/or an interface, and it is characterized by preparing like ion grouting which pours ion into said detached core before said 3rd process in the exfoliation approach of a thin film device of having the 3rd process which makes said substrate exfoliating from said detached core.

[0015] The detached core which has the property which absorbs light that the dependability in device manufacture is high, on substrates, such as a quartz substrate, is prepared, for example, and thin film devices, such as TFT, are formed on the substrate. It joins to the imprint object of a request of a thin film device through the glue line preferably next. Light is irradiated after that at a detached core, and it produces and cheats out of an exfoliation phenomenon in the detached core. Thereby, a thin film device can be made to exfoliate from a substrate by applying the force to a substrate.

[0016] The exfoliation phenomenon of the detached core in an exfoliation process can become remarkable, and a thin film device can be made to exfoliate from a substrate certainly by pouring ion into a detached core in front of an exfoliation process at this time.

[0017] Here, by pouring ion into a detached core beforehand, the operation defined as either of claims 2-5 is made, and the exfoliation phenomenon of a detached core becomes remarkable.

[0018] According to claim 2, the process by which said ion poured into said detached core is gasified is included in said three processes. If the ion in a detached core is gasified, in a detached core, internal pressure will arise and the exfoliation phenomenon will be promoted.

[0019] In this case, light can be irradiated at a detached core and the ion for exfoliation can be made to gasify by that light, as shown in claim 3. If an optical exposure is carried out at this time [side / of a substrate / rear-face], the quantity of light by which optical incidence is carried out to a thin film device layer can be reduced, and degradation of that property can be prevented.

[0020] According to claim 4, like said ion grouting, association of the atom or molecule which constitutes said detached core with said ion is cut, and a damage is beforehand given to said detached core. Therefore, the exfoliation phenomenon in the detached core produced at a subsequent exfoliation process is promoted.

[0021] According to claim 5, like said ion grouting, the property of said detached core is changed with said ion, and the adhesion of said detached core and said substrate is weakened beforehand. Therefore, the exfoliation phenomenon in the detached core produced at a subsequent exfoliation process is promoted.

[0022] Invention of claim 6 has a thin film transistor formation process for said 2nd process to form a thin film transistor in claim 1 thru/or either of 5, and said thin film transistor formation process is characterized by carrying out after said channel layer formation process like said ion grouting including a channel layer formation process.

[0023] A channel formation process turns into a high-temperature-processing process as compared with other processes. Therefore, it is because there is a possibility that ion may be emitted from a detached core at the time of subsequent high temperature processing when the ion for exfoliation phenomenon promotion is poured in before that at the detached core.

[0024] Invention of claim 7 is characterized by carrying out said thin film transistor formation process after said channel pattern formation process like said ion grouting including a channel pattern formation process after said channel layer formation process in claim 6.

[0025] If the channel pattern is formed, even if it pours in the ion for exfoliation phenomenon promotion from a channel pattern side, the area of the channel pattern itself which can serve as a failure of the impregnation will decrease. Therefore, it becomes that it is easy to make ion reach to a detached core.

[0026] Invention of claim 8 is characterized by forming a mask among said channel layers on a channel field and the becoming field, and carrying out like said ion grouting in claims 6 or 7.

[0027] It is because there is a possibility that transistor characteristics may deteriorate when ion is poured into a channel field. In addition, the process which carries out the mask of the channel field and carries out an ion implantation may be before channel pattern formation or after formation.

[0028] In claim 9, said thin film transistor formation process is characterized by carrying out like said ion grouting by using said gate electrode as a mask after said channel pattern formation process including the process which forms gate dielectric film on this channel pattern, and the process which forms a gate electrode on this gate dielectric film in claim 7.

[0029] Since a gate electrode is formed in a channel and the location which counters, a gate electrode can be used also [field / channel] as a mask with which ion prevents pouring into a channel field. In addition, according to the acceleration voltage of ion, a mask may be further formed on a gate electrode.

[0030] Invention of claim 10 is characterized by pouring into coincidence the impurity ion driven into either [at least] the source field in said channel pattern, or a drain field, and said ion which mass is lighter than it and is driven into said detached core like said ion grouting in claims 8 or 9.

[0031] If it carries out like this, it can be made to serve a double purpose like impurity ion grouting to the source and/or a drain field like ion grouting to a detached core. In addition, since mass is lighter than impurity ion, ion can reach to the detached core in a location deeper than the source and a drain field.

[0032] Invention of claim 11 is characterized by carrying out said thin film transistor formation process in front of said crystallization process like said ion grouting including the process which forms an amorphous silicon layer as said channel layer, and the crystallization process which carries out laser annealing of the account amorphous silicon layer of back to front, and is crystallized in claim 6.

[0033] Crystallinity is raised by the subsequent laser annealing process even if a damage should arise in a channel layer by operation like ion grouting.

[0034] Invention of claim 12 is characterized by said ion being a hydrogen ion in claim 1 thru/or either of 11.

[0035] If a hydrogen ion is poured into a detached core, it can be made to contribute to the operation shown in each of claims 2-4. Since mass is lighter than the source and the impurity ion (boron, Lynn, etc.) driven into a drain, especially the hydrogen ion also fits implementation of invention of claim 9. In addition, as ion which mainly produces gasification of claim 2, nitrogen ion etc. can be mentioned other than a hydrogen ion. Moreover, as ion which mainly produces the damage of claims 3 and 4, or an adhesion fall, Si ion etc. can be mentioned other than a hydrogen ion.

[0036] Invention of claim 13 is characterized by said ion grouting making process temperature of

the process carried out behind less than 350 degrees C in claim 12.

[0037] Since it begins to escape from the hydrogen poured into the detached core by being heated by 350 degrees C or more, as for the process which needs the process temperature of 350 degrees C or more, it is as desirable as ion grouting to a detached core to carry out in front.

[0038] Invention of claim 14 defines the thin film device which uses the exfoliation approach of ** for claim 1 thru/or either of 13, exfoliates from said substrate, and changes. Since the exfoliation from a detached core is easy for this thin film device, there is little mechanical pressure which acts at the time of exfoliation, it ends, and can lessen the defect depending on the magnitude of that load.

[0039] Invention of claim 15 is a active-matrix substrate with which the pixel section is constituted including the thin film transistor arranged in the shape of a matrix, and the pixel electrode connected to the end of the thin film transistor, and defines the active-matrix substrate manufactured by imprinting the thin film transistor of said pixel section using an approach according to claim 6 to 13.

[0040] This active-matrix substrate as well as invention of claim 13 can lessen a defect.

[0041] Invention of claim 16 defines the liquid crystal display manufactured using the active-matrix substrate according to claim 15.

[0042] Since the active-matrix substrate of claim 15 is used for this liquid crystal display, its defect as the whole liquid crystal display also decreases.

[0043] The imprint approach of the thin film device concerning invention of claim 17 The 1st process which forms the 1st detached core on a substrate, and the 2nd process which forms the transferred layer containing a thin film device on said 1st detached core, The 3rd process which forms the 2nd detached core which consists of water solubility or organic solvent melting nature adhesives on said transferred layer, It borders on said 1st detached core at the 4th process which joins a primary imprint object on said 2nd detached core. The 5th process which removes said substrate from said transferred layer, and the 6th process which joins a secondary imprint object to the inferior surface of tongue of said transferred layer, Said 2nd detached core is contacted to water or an organic solvent, and it has the 7th process which removes said primary imprint object from said transferred layer bordering on said 2nd detached core, and is characterized by imprinting said transferred layer containing said thin film device on a secondary imprint object.

[0044] After removing the 1st detached core and joining a secondary imprint object to the inferior surface of tongue from the inferior surface of tongue of a transferred layer, it is made to secede from a primary imprint object from a transferred layer bordering on the 2nd detached core according to invention of claim 17. If it carries out like this, a secondary imprint object will exist in the location in which the original substrate was located to a transferred layer, and the laminating relation of the transferred layer to the original substrate and the laminating relation of the transferred layer to a secondary imprint object are in agreement. here, since water-soluble adhesives or organic solvent melting nature adhesives is used as the 2nd detached core, the 2nd detached core is contacted to water or an organic solvent making it secede from a primary imprint object — being sufficient .

[0045] By the imprint approach of the thin film device concerning invention of claim 18, as the 2nd detached core under approach invention of claim 17, it replaces with the above-mentioned adhesives and the adhesives which can exfoliate by heating or ultraviolet rays are used.

[0046] In this case, if the 2nd detached core is contacted in the adhesives which can exfoliate by heating or ultraviolet rays making it secede from a primary imprint object, the laminating relation of the transferred layer to the original substrate and the laminating relation of the transferred layer to a secondary imprint object can be made in agreement like invention of claim 17.

[0047]

[Embodiment of the Invention] Next, the gestalt of operation of this invention is explained with reference to a drawing.

[0048] <Gestalt of the 1st operation> drawing 1 – drawing 6 are drawings for explaining the

imprint approach of the thin film device which will be the requisite for this invention.

[0049] As shown in [process 1] drawing 1, a detached core (light absorption layer) 120 is formed on a substrate 100.

[0050] Hereafter, a substrate 100 and a detached core 120 are explained.

[0051] ** What has the translucency which light may penetrate is used for the explanation substrate 100 about a substrate 100.

[0052] In this case, as for the permeability of light, it is desirable that it is 10% or more, and it is more desirable that it is 50% or more. When this permeability is too low, attenuation (loss) of light becomes large and needs the big quantity of light by exfoliating a detached core 120.

[0053] Moreover, as for a substrate 100, it is desirable to consist of reliable ingredients, and it is desirable to consist of ingredients which were excellent in thermal resistance especially.

Although the reason has what process temperature becomes high depending on the class and formation approach (for example, about 350–1000 degrees C) in case it forms the transferred layer 140 and interlayer 142 who mention later, it is because the width of face of a setup of membrane formation conditions, such as the temperature condition, will spread even in such a case on the occasion of formation of the transferred layer 140 grade to a substrate 100 top if the substrate 100 is excellent in thermal resistance.

[0054] Therefore, a substrate 100 has a desirable consisting-of [the strain point]-ingredients more than Tmax thing, when the maximum temperature in the case of formation of the transferred layer 140 is set to Tmax. A thing 350 degrees C or more has a desirable strain point, and, specifically, the component of a substrate 100 has a more desirable thing 500 degrees C or more. As such a thing, the heat resisting glass of quartz glass, Corning 7059, and NEC glass OA-2 grade is mentioned, for example.

[0055] Moreover, although especially the thickness of a substrate 100 is not limited, it is desirable that it is about 0.1–5.0mm, and it is usually more desirable that it is about 0.5–1.5mm. If the thickness of a substrate 100 is too thin, a strong fall will be caused, and if too thick, when the permeability of a substrate 100 is low, it will become easy to produce attenuation of light. In addition, when the permeability of the light of a substrate 100 is high, the thickness may exceed said upper limit. In addition, as for the thickness of a substrate 100, it is desirable that it is uniform so that light can be irradiated at homogeneity.

[0056] ** The explanation detached core 120 of a detached core 120 is receiving any one or two or more operations of physical operations (light, heat, etc.), chemical operations (chemical reaction with a drug solution etc.), or mechanical works (hauling force, vibration, etc.), that bonding strength is decreased or extinguished and this urges separation of a substrate 100 to it through this detached core 120.

[0057] The light which it considers as this detached core 120, for example, is irradiated can be absorbed, and what has a property which produces exfoliation (henceforth "exfoliation in a layer" and "interfacial peeling") in the inside of that layer and/or an interface can be mentioned. What it arises that the bonding strength between the atoms of the matter which constitutes a detached core 120, or between molecules disappears or decreases, i.e., ablation, and results in the exfoliation in a layer and/or interfacial peeling by the exposure of light preferably is good.

[0058] Furthermore, a gas may be emitted by the exposure of light from a detached core 120, and the separation effectiveness may be discovered. That is, a detached core 120 absorbs light, it becomes a gas to the case where the component contained in the detached core 120 serves as a gas, and it is emitted for a moment, the steam is emitted, and it may contribute to separation.

[0059] In this invention, after forming the detached core 120 which has such a property, it is the description to pour in the ion for exfoliation promotion into a detached core 120, and, thereby, the exfoliation phenomenon in the detached core 120 in a subsequent process is promoted. Therefore, a class will not be asked if the exfoliation phenomenon by the physical operation, chemical operation, or mechanical work mentioned above is promoted as ion for exfoliation promotion.

[0060] Next, as a presentation of such a detached core 120, what is indicated by following A–E is mentioned, for example.

[0061] A. Amorphous silicon (a-Si)

Hydrogen (H) may contain in this amorphous silicon. In this case, as for the content of H, it is desirable that it is extent more than 2 atom %, and it is more desirable that it is 2 – 20 atom % extent. Thus, if specified quantity content of the hydrogen (H) is carried out, by making light an exposure behind, hydrogen will be emitted, internal pressure will occur in a detached core 120, and it will become the force in which it exfoliates an up-and-down thin film. The content of the hydrogen in an amorphous silicon (H) can be adjusted by setting up suitably conditions, such as membrane formation conditions, for example, the gas presentation in CVD, gas pressure, a gas ambient atmosphere, a quantity of gas flow, temperature, substrate temperature, and injection power.

[0062] With the gestalt of this operation, the ion implantation of the hydrogen ion can be carried out as ion for exfoliation promotion at one after formation of an amorphous silicon layer of stages as hydrogen is made to contain in a detached core 120 according to this process condition and also being mentioned later. Thereby, the hydrogen more than a constant rate can be made to contain in an amorphous silicon layer, without being influenced by the process conditions of an amorphous silicon.

[0063] B. As various oxide ceramics, such as silicon oxide or a silicic-acid compound, titanium oxide or a titanac-acid compound, a zirconium dioxide or a zirconic acid compound, a lanthanum trioxide, or a lanthanum oxidation compound, ***** (ferroelectric), or semi-conductor silicon oxide, SiO, SiO₂, and Si₃O₂ are mentioned, and K₂SiO₃, Li₂SiO₃, CaSiO₃ and ZrSiO₄, and Na₂SiO₃ are mentioned as a silicic-acid compound, for example.

[0064] TiO, Ti₂O₃, and TiO₂ mention as titanium oxide — having — as a titanac-acid compound — BaTiO₄, BaTiO₃, Ba₂Ti₉O₂₀, BaTi₅O₁₁, and CaTiO₃, SrTiO₃, PbTiO₃, MgTiO₃, ZrTiO₂, SnTiO₄ and aluminum₂ — TiO₅ and FeTiO₃ are mentioned.

[0065] As a zirconium dioxide, ZrO₂ is mentioned and BaZrO₃, ZrSiO₄, PbZrO₃, MgZrO₃, and K₂ZrO₃ are mentioned as a zirconic acid compound, for example.

[0066] C. The ceramics or dielectrics (ferroelectric), such as PZT, PLZT, PLLZT, and PBZT

D. As nitride-ceramics E. organic polymeric-materials organic polymeric materials, such as silicon nitride, nitriding aluminum, and titanium nitride — CH-, —CO- (ketone), —CONH- (amide), —NH- (imide), — As long as it is what has association (these association is cut by the exposure of light) of COO- (ester), —N=N- (azo), —CH=N- (CIF), etc., and the thing which has many these association especially, what kind of thing may be used. Moreover, organic polymeric materials may have aromatic hydrocarbon (1, two or more benzene rings, or condensed ring of those) in a constructive mood.

[0067] As an example of such organic polymeric materials, polyethylene, polyolefine like polypropylene, polyimide, a polyamide, polyester, polymethylmethacrylate (PMMA), polyphenylene sulfide (PPS), polyether sulphone (PES), an epoxy resin, etc. are raised.

[0068] F. As a metal metal, the alloy containing at least one of aluminum, Li, Ti, Mn, In, Sn, Y, La, Ce, Nd, Pr, Gd, Sm, or sorts of these is mentioned, for example.

[0069] Moreover, although the thickness of a detached core 120 changes with terms and conditions, such as a presentation of the exfoliation purpose or a detached core 120, lamination, and the formation approach, it is desirable that it is 1nm — about 20 micrometers, it is more desirable that it is 5nm — about 2 micrometers, and it is usually still more desirable [thickness] that it is 5nm — about 1 micrometer. While enlarging power (quantity of light) of light in order to secure the good detachability of a detached core 120 if the homogeneity of membrane formation is spoiled, nonuniformity may arise in exfoliation, when the thickness of a detached core 120 is too small, and thickness is too thick, in case a detached core 120 is removed behind, the activity takes time amount. In addition, as for the thickness of a detached core 120, it is desirable that it is uniform as much as possible.

[0070] Especially the formation approach of a detached core 120 is not limited, but is suitably chosen according to terms and conditions, such as a film presentation and thickness. For example, it CVD(s) (MOCVD and low voltage — CVD and ECR-CVD are included). Vacuum evaporationo, molecular beam deposition (MB), sputtering, ion plating, The various gaseous-phase forming-membranes methods, such as PVD, electroplating, immersion plating (dipping),

various plating, such as electroless deposition, and the Langmuir pro jet (LB) — law — The applying methods, such as a spin coat, a spray coat, and a roll coat, various print processes, a replica method, the ink jet method, a powder jet process, etc. are mentioned, and it can also form or more [of these] combining two.

[0071] For example, when the presentation of a detached core 120 is an amorphous silicon (a-Si), it is desirable to form membranes by CVD especially low voltage CVD, or plasma CVD.

[0072] Moreover, when a detached core 120 is constituted from ceramics by the sol-gel method, or when it constitutes from organic polymeric materials, it is desirable the applying method and to form membranes with a spin coat especially.

[0073] As shown in [a process 2], next drawing 2, the transferred layer (thin film device layer) 140 is formed on a detached core 120. Although the detail after this process 2 is later explained with reference to drawing 8 – drawing 18, it is carrying out like ion grouting for exfoliation promotion to a detached core 120 with the gestalt of this operation in the middle of the process of drawing 8 – drawing 13.

[0074] The expanded sectional view of K part (part shown by surrounding with 1 dotted-line chain line in drawing 2) of this thin film device layer 140 is shown in the right-hand side of drawing 2. It is constituted including TFT (thin film transistor) formed on SiO₂ film (middle class) 142, and the thin film device layer 140 possesses the source and the drain layer 146 which this TFT introduced n mold impurity into the polish recon layer, and were formed, the channel layer 144, gate dielectric film 148, the gate electrode 150, an interlayer insulation film 154, and the electrode 152 that consists of aluminum so that it may be illustrated.

[0075] Although SiO₂ film is used with the gestalt of this operation as an interlayer prepared in contact with a detached core 120, the insulator layer of others, such as Si₃N₄, can also be used. Although the thickness of SiO₂ film (interlayer) is suitably determined according to the formation purpose or extent of a function which can be demonstrated, it is desirable that it is 10nm – about 5 micrometers, and it is usually more desirable that it is 40nm – about 1 micrometer. What demonstrates at least one of the functions as the protective layer which an interlayer is formed for the various purpose, for example, protects the transferred layer 140 physically or chemically, an insulating layer, a conductive layer, the protection-from-light layer of laser light, the barrier layer for migration prevention, and a reflecting layer is mentioned.

[0076] In addition, the middle class, such as SiO₂ film, may not be formed depending on the case, but the direct transferred layer (thin film device layer) 140 may be formed on a detached core 120.

[0077] The transferred layer 140 (thin film device layer) is a layer containing thin film devices, such as TFT as shown in the right-hand side of drawing 2.

[0078] As a thin film device, besides TFT, for example, a thin-film diode, The optoelectric transducer (the photosensor, solar battery) and silicon resistance element which consist of PIN junction of silicon, Other thin film semiconductor devices, an electrode (example: a transparent electrode like ITO and the mesa film), Actuators, such as a switching element, memory, and a piezoelectric device, a micro mirror (piezo thin film ceramics), There are a micro MAG device which combined a magnetic-recording thin film head, a coil, an inductor, the charge of a thin film quantity magnetic-permeable material, and them, a filter, reflective film, a dichroic mirror, etc.

[0079] Such a thin film device is formed through usually comparatively high process temperature by relation with the formation approach. Therefore, as mentioned above in this case, as a substrate 100, the thing which has high dependability and which can bear that process temperature is needed.

[0080] As shown in [a process 3], next drawing 3, the thin film device layer 140 is joined to the imprint object 180 through a glue line 160 (adhesion).

[0081] As a suitable example of the adhesives which constitute a glue line 160, various hardening mold adhesives, such as photo-curing mold adhesives, such as reaction hardening mold adhesives, heat-curing mold adhesives, and ultraviolet curing mold adhesives, and aversion hardening mold adhesives, are mentioned. As a presentation of adhesives, what kind of thing is sufficient as an epoxy system, an acrylate system, a silicone system, etc., for example. Formation of such a glue line 160 is made for example, by the applying method.

[0082] After applying hardening mold adhesives on the transferred layer (thin film device layer) 140 and joining the imprint object 180 on it when using said hardening mold adhesives for example, said hardening mold adhesives are stiffened by the hardening approach according to the property of hardening mold adhesives, and the transferred layer (thin film device layer) 140 and the imprint object 180 are pasted up, and it fixes. [0083] when adhesives are photo-curing molds, light is irradiated from the substrate of light transmission nature, and both the outsides of an imprint object or — from one outside of the substrate 100 of light transmission nature, or the imprint object 180 of light transmission nature. As adhesives, photo-curing mold adhesives, such as an ultraviolet curing mold which cannot affect a thin film device layer easily, are desirable.

[0084] Water-soluble adhesives can also be used as a glue line 160. As this kind of water-soluble adhesives, it is KEMISHIRU made from for example, KEMITEKKU, Inc. Three Bond 3046 (trade name) by U-451D (trade name) and Three Bond Co., Ltd. etc. can be mentioned.

[0085] The adhesives which have melting nature to various kinds of organic solvents as a glue line 160 can also be used.

[0086] As a glue line 160, the adhesives which present an exfoliation operation with heating can also be used. As this kind of adhesives, RIBAARUFA made from for example, Japanese east DENKO (trade name) can be used.

[0087] As a glue line 160, the adhesives which present an exfoliation operation by UV irradiation can also be used. As this kind of adhesives, the dicing tape D-210 for glass ceramics by LINTEC Corp. and D-636 can be used.

[0088] In addition, unlike illustration, a glue line 160 may be formed in the imprint object 180 side, and the transferred layer (thin film device layer) 140 may be pasted up on it. In addition, when imprint object 180 the very thing has an adhesion function, for example, formation of a glue line 160 may be omitted.

[0089] although not limited especially as an imprint object 180 — a substrate (plate) — especially a transparency substrate is mentioned. In addition, such a substrate may be monotonous or may be a curve plate. Moreover, compared with said substrate 100, properties, such as thermal resistance and corrosion resistance, may be inferior in the imprint object 180. It is because the reason forms the transferred layer (thin film device layer) 140 in a substrate 100 side in this invention, and imprints the transferred layer (thin film device layer) 140 on the imprint object 180 after that, so it does not depend on the temperature conditions in the case of formation of the transferred layer (thin film device layer) 140 etc. for the property required of the imprint object 180, especially thermal resistance.

[0090] Therefore, when the maximum temperature in the case of formation of the transferred layer 140 is set to Tmax, a glass transition point (Tg) or softening temperature can use the following [Tmax] as a component of the imprint object 0. For example, a glass transition point (Tg) or softening temperature can constitute more preferably 800 degrees C or less of 500 degrees C or less of imprint objects 180 from an ingredient 320 degrees C or less still more preferably.

[0091] Moreover, although what has a certain amount of rigidity (reinforcement) as a mechanical property of the imprint object 180 is desirable, you may have flexibility and elasticity.

[0092] As a component of such an imprint object 180, various synthetic resin or various glass material are mentioned, and various synthetic resin and the usual cheap glass material (low melting point) are desirable especially.

[0093] As synthetic resin, any of thermoplastics and thermosetting resin are sufficient. For example, polyethylene, a polo propylene, an ethylene-pre pyrene copolymer, Polyolefines, such as an ethylene-vinylacetate copolymer (EVA), annular polyolefine, Denaturation polyolefine, a polyvinyl chloride, a polyvinylidene chloride, polystyrene, A polyamide, polyimide, polyamidoimide, a polycarbonate, Polly (4-methyl BENTEN -1), An ionomer, acrylic resin, polymethylmethacrylate, an acrylic-styrene copolymer (AS resin), Butadiene Styrene, a polio copolymer (EVOH), polyethylene terephthalate (PET), Polyester, such as polyp CHIREN terephthalate (PBT) and PURISHI clo hexane terephthalate (PCT), A polyether, a polyether ketone (PEK), a polyether ether ketone (PEEK), Polyether imide, polyacetal (POM), polyphenylene oxide, Denaturation polyphenylene oxide, polyarylate, aromatic polyester (liquid crystal polymer),

Polytetrafluoroethylene, polyvinylidene fluoride, other fluorine system resin, A styrene system, a polyolefine system, a polyvinyl chloride system, a polyurethane system, Various thermoplastic elastomer, such as a fluororubber system and a chlorinated polyethylene system, EBOKISHI resin, phenol resin, a urea resin, melamine resin, unsaturated polyester, The copolymer which is mainly concerned with these, a blend object, a polymer alloy, etc. are mentioned, and silicone resin, polyurethane, etc. can be used combining 1 of sorts of these, and two sorts or more (as a layered product for example, more than two-layer).

[0094] As glass material, silicic-acid glass (quartz glass), silicic-acid alkali glass, soda lime glass, potash lime glass, lead (alkali) glass, barium glass, borosilicate glass, etc. are mentioned, for example. Among these, compared with silicic-acid glass, the melting point is low, and shaping and processing are also comparatively easy the melting point, and, moreover, things other than silicic-acid glass have it, and are desirable. [cheap]

[0095] When using what consisted of synthetic resin as an imprint object 180, while being able to fabricate the large-scale imprint object 180 in one, even if it is complicated configurations, such as what has a curve side and irregularity, it can manufacture easily, and the various advantages that ingredient cost and a manufacturing cost are also cheap can be enjoyed. Therefore, use of synthetic resin is advantageous when manufacturing a large-sized and cheap device (for example, liquid crystal display).

[0096] In addition, the imprint object 180 may constitute some devices like what constitutes the device which became independent in itself like a liquid crystal cell, a color filter and an electrode layer, a dielectric layer, an insulating layer, and a semiconductor device.

[0097] Furthermore, the imprint objects 180 may be matter, such as a metal, ceramics, a stone, and wood paper, and may be on the front face of the structures, such as a wall, a column, head lining, and a windowpane, further on the field of the arbitration which constitutes a certain article (superiors of the front-face top of the field top of a clock, and an air-conditioner, and a printed circuit board).

[0098] As shown in [a process 4], next drawing 4, light is irradiated from the rear-face side of a substrate 100.

[0099] After this light penetrates a substrate 100, it is irradiated by the detached core 120. Thereby, the exfoliation in a layer and/or interfacial peeling arise in a detached core 120, and bonding strength is decreased or extinguished.

[0100] It is presumed that it is what is depended on phase changes, such as that ablation produces the principle which the exfoliation in a layer and/or interfacial peeling of a detached core 120 produce in the component of a detached core 120 and emission of the gas contained in the detached core 120, melting further produced immediately after an exposure, and evapotranspiration.

[0101] The fixed ingredient (component of a detached core 120) which absorbed exposure light is excited photochemistry-wise or thermally, ablation means association of the atom of the front face and interior or a molecule being cut, and emitting here, and it mainly appears as a phenomenon in which all or a part of component of a detached core 120 produces phase changes, such as melting and evapotranspiration (evaporation). Moreover, by said phase change, it may be in a minute firing condition and bonding strength may decline.

[0102] Conditions, such as a presentation of a detached core 120, and a class of light irradiated as one of the factor of the, wavelength, reinforcement, the attainment depth, are mentioned by in addition to this being influenced by various factors they are [whether a detached core 120 produces the exfoliation in a layer interfacial peeling is produced, or] the both.

[0103] Here, with the gestalt of this operation, after formation of a detached core 120, in order to make detached core 120 the very thing produce an exfoliation phenomenon more certainly at this 4th process, the ion for exfoliation promotion is poured in.

[0104] This ion for exfoliation promotion promotes three either of the followings, or the exfoliation phenomenon of the detached core [in / for an operation of two or more combination / nothing and the 4th process] 120 at least.

[0105] The ion for exfoliation promotion, for example, the hydrogen, (H) or nitrogen (N) with which one of them was poured into the detached core 120 by operation of this 4th process is

gasified, and, thereby, exfoliation of a detached core 120 is promoted.

[0106] Other one was set like ion grouting for exfoliation promotion, it cut association of the atom or molecule which constitutes a detached core 120 with the ion for exfoliation promotion, for example, hydrogen, (H), nitrogen (N), or silicon (Si), and has given the damage beforehand to the detached core 120. Therefore, in the detached core 120 to which the damage was given beforehand, exfoliation arises comparatively easily by operation of the 4th process.

[0107] One of further others is set like ion grouting for exfoliation promotion, it changes the property of a detached core 120 with the ion for exfoliation promotion, for example, hydrogen, (H), nitrogen (N), or silicon (Si), and the adhesion of a detached core 120 and a substrate 100 has weakened it beforehand. Also in this case, in the detached core 120 which the adhesion with a substrate was able to weaken, exfoliation arises comparatively easily by operation of the 4th process.

[0108] As a light irradiated at the 4th process, if a detached core 120 is made to start the exfoliation in a layer, and/or interfacial peeling, what kind of thing may be used, for example, an X-ray, ultraviolet rays, the light, infrared radiation (heat ray), a laser beam, a millimeter wave, microwave, an electron ray, a radiation (alpha rays, beta rays, gamma ray), etc. will be mentioned. A laser beam is desirable at the point of being easy to produce exfoliation (ablation) of a detached core 120 also in it.

[0109] As laser equipment made to generate this laser beam, although various gas laser, solid state laser (semiconductor laser), etc. are mentioned, excimer laser, Nd-YAG laser, Ar laser, a CO₂ laser, a CO laser, helium-Ne laser, etc. are used suitably, and especially excimer laser is desirable also in it.

[0110] Since it outputs high energy in a short wavelength region, extremely, excimer laser can make a detached core 120 produce ablation for a short time, and it can exfoliate a detached core 120, without making the imprint object 180 and substrate 100 grade which therefore adjoin produce most temperature rises (i.e., without it producing degradation and damage).

[0111] Moreover, when it makes it faced that a detached core 120 produces ablation and there is a wavelength dependency of light, as for the wavelength of the laser beam irradiated, it is desirable that it is 100nm – about 350nm.

[0112] An example of permeability to the wavelength of light of a substrate 100 is shown in drawing 7. It has the property that permeability increases steeply to the wavelength of 200nm so that it may be illustrated. In such a case, light (wavelength of 308nm) with a wavelength of 210nm or more, for example, Xe-Cl excimer laser light, KrF laser light (wavelength of 248nm), etc. are irradiated.

[0113] Moreover, when making a detached core 120 cause phase changes, such as a gas evolution, evaporation, and sublimation, and giving a separation property to it, as for the wavelength of the laser beam irradiated, it is desirable that it is about 350 to 1200nm.

[0114] Moreover, as for especially the energy density in the case of excimer laser, it is desirable the energy density of the laser beam irradiated and to consider as about two 10 – 5000 mJ/cm, and it is more desirable to consider as about two 100 – 500 mJ/cm. Moreover, as for irradiation time, it is desirable to be referred to as about 1 – 1000ns, and it is more desirable to be referred to as about 10 – 100ns. When sufficient ablation etc. does not arise, and an energy density is high, when an energy density is low or irradiation time is short, or irradiation time is long, there is a possibility of having a bad influence on the transferred layer 140 by the exposure light which penetrated the detached core 120.

[0115] In addition, as a cure in case the exposure light which penetrated the detached core 120 reaches even the transferred layer 140 and does a bad influence, as shown in drawing 30, there is the approach of forming the metal membranes 124, such as a tantalum (Ta), on a detached core (laser absorption layer) 120, for example. Thereby, it is completely reflected by the interface of a metal membrane 124, and the laser light which penetrated the detached core 120 does not have a bad influence on the thin film device above it.

[0116] Next, the force is applied to a substrate 100 and this substrate 100 is made to secede from a detached core 120, as shown in drawing 5. Although not illustrated in drawing 5, a detached core may adhere on a substrate 100 after this balking.

[0117] Next, as shown in drawing 6, the extant detached core 120 is removed by the approach which combined approaches, such as washing, etching, ashing, and polish, or these. It means that the transferred layer (thin film device layer) 140 had been imprinted by the imprint object 180 by this.

[0118] In addition, when a part of detached core has adhered also to the substrate 100 from which it seceded, it removes similarly. In addition, when the substrate 100 consists of an expensive ingredient like quartz glass, and a rare ingredient, reuse (recycle) is preferably presented with a substrate 100. That is, this invention can be applied to the substrate 100 to reuse, and usefulness is high.

[0119] The imprint to the imprint object 180 of the transferred layer (thin film device layer) 140 is completed through each above process. Then, conductive layers, such as removal of SiO₂ film which adjoins the transferred layer (thin film device layer) 140, and wiring of a up to [the transferred layer 140], formation of a desired protective coat, etc. can also be performed.

[0120] Thus, transferred layer (thin film device layer) 140 the very thing which is an exfoliated object is not exfoliated directly. Since it exfoliates in the detached core joined to the transferred layer (thin film device layer) 140, Irrespective of the property of an exfoliated object (transferred layer 140), conditions, etc., easily and certainly, it can exfoliate in homogeneity (imprint), there is also no damage to the exfoliated object (transferred layer 140) in accordance with exfoliation actuation, and the high dependability of the transferred layer 140 can be maintained.

[0121] Next, TFT of for example, CMOS structure is formed as a thin film device layer 140 on a substrate 100 and a detached core 120, and the example of the concrete manufacture process in the case of imprinting this on an imprint object is explained using drawing 8 – drawing 18. In addition, even if it attaches like ion grouting for exfoliation promotion carried out in the middle of this process, it explains.

[0122] (Process 1) as shown in drawing 8, on the translucency substrate (for example, quartz substrate) 100, laminating formation of a detached core (for example, LPCVD amorphous silicon layer formed of law) 120, an interlayer (for example, SiO₂ film) 142, and the amorphous silicon layer (for example, LPCVD — formed of law) 143 is carried out one by one, then laser light is irradiated from the upper part all over the amorphous silicon layer 143, and annealing is given. Thereby, the amorphous silicon layer 143 is recrystallized and turns into a polish recon layer. In addition, when carrying out laser annealing in this case with a beam scan, it is desirable in the same part that an optical exposure is carried out 2 times or more so that the beam cores of the beam of each time may lap unlike the beam scan to the above-mentioned detached core 120 (it removes in the case of a Gaussian beam). In this case, it is because there are no evils, such as optical leakage, and the amorphous silicon layer 143 can fully be recrystallized by carrying out a multiplex exposure.

[0123] If it is after formation of a detached core 120 and is before the laser annealing process for crystallization as an operation stage of the impregnation process of the ion for exfoliation promotion, it is desirable at the point that an ion implantation can be carried out without needing a mask.

[0124] Therefore, as the operation stage, it is after formation of the detached core 120 of (A) drawing 8, is after formation of an interlayer's 142 (B) interlayer 142 before formation, is after formation of the amorphous silicon layer 143 (before [C]) formation of the amorphous silicon layer 143, and becomes either in front of the laser annealing process for the crystallization. This (A) In – (C), the operation stage of (C) is the most desirable. In the reason, the formation process of the amorphous silicon layer 143, i.e., the formation process of a channel layer, serves as process temperature of about 425 degrees C in the present condition. When the hydrogen ion is already poured into the detached core 120 as in this case, for example, ion for exfoliation promotion, there is a possibility that hydrogen may escape from and come out of a detached core 120 at the temperature of 350 degrees C or more. Therefore, as for the impregnation process of the ion for exfoliation promotion, it is desirable to carry out with the operation stage after the channel stratification (C). However, since there is such no limit depending on the class of ion for exfoliation promotion, an operation stage (A) and (B) can also be carried out. Moreover, it is desirable on transistor characteristics that the damage resulting from impregnation of the

ion for exfoliation promotion has not arisen in the layer after laser annealing of the amorphous silicon layer 143 was carried out and it was polycrystal-ized. In being (C), even if there is no generating of a damage itself in (A) and (B), and a damage arises in amorphous silicon layer 143 the very thing, the effect of the damage will be reduced according to a subsequent crystallization process.

[0125] In addition, like this ion grouting for exfoliation promotion, it can carry out using well-known ion implantation equipment. That is, if a hydrogen ion is poured in, for example, the gas containing hydrogen is plasma-ized and the hydrogen ion generated by it can be poured into a detached core 120 by accelerating by electric field.

[0126] As an operation stage like ion grouting (D), you may be after laser annealing. In this case, transistor characteristics will not be degraded, if the mask of the part used as a channel field is carried out and it carries out an ion implantation. In addition, as for a mask, ion grouting is removed behind. As it is alike (process 2), then is shown in drawing 9, patterning of the polish recon layer obtained by laser annealing is carried out, and Islands 144a and 144b are formed as a channel pattern.

[0127] Like ion grouting for exfoliation promotion, it can carry out after the 2nd process (channel pattern formation process) as the operation stage (E) besides (A) – (D) mentioned above. In this case, as shown in drawing 31, it is on island 144a and 144b, and the mask pattern 201 is formed in the channel field in island 144a and 144b, and the part which counters. And the ion for exfoliation promotion, for example, a hydrogen ion, is turned and poured into a detached core 120 in the condition. Thereby, hydrogen does not contain to a channel field and transistor characteristics do not deteriorate. In addition, if it ends like ion grouting for exfoliation promotion, a mask pattern 201 will be removed.

[0128] (Process 3) As shown in drawing 10, wrap gate dielectric film 148a and 148b is formed for Islands 144a and 144b with a CVD method.

[0129] Like ion grouting for exfoliation promotion, it can carry out after the 3rd process (gate dielectric film) as the operation stage (F) besides (A) – (E) mentioned above. In this case, as shown in drawing 32, it is on gate-dielectric-film 148a and 148b, and it is desirable to form a mask pattern 202 in the channel field in island 144a and 144b and the part which counters.

[0130] (Process 4) As shown in drawing 11, the gate electrodes 150a and 150b which consist of polish recon or metal are formed.

[0131] (Process 5) As shown in drawing 12, the mask layer 170 which consists of polyimide etc. is formed, using gate electrode 150b and the mask layer 170 as a mask, it is a self aryne, for example, the ion implantation of boron (B) is performed. Of this, the p+ layers 172a and 172b are formed.

[0132] Like ion grouting for exfoliation promotion, this boron ion grouting simultaneously can be carried out as that operation stage (G) besides (A) – (F) mentioned above. In this case, the mixed gas of B-2H6(5%)+H2 (95%) is plasma-ized, the boron ion and hydrogen ion which were generated by that cause are accelerated, and it leads to a substrate, without minding a mass spectrograph. If it does so, even if it is the same acceleration voltage, while the boron ion with heavy mass stops at the polycrystalline silicon layer by the side of the upper layer, the hydrogen ion with light mass will be driven in more deeply, and it will reach to a detached core 120.

[0133] In addition, although gate electrode 150b functions as the mask pattern 201 of drawing 31, or the mask pattern 202 of drawing 32 similarly at this time, according to acceleration voltage, a mask layer can be further prepared on gate electrode 150b.

[0134] (Process 6) As shown in drawing 13, the mask layer 174 which consists of polyimide etc. is formed, using gate electrode 150a and the mask layer 174 as a mask, it is a self aryne, for example, the ion implantation of Lynn (P) is performed. Of this, the n+ layers 146a and 146b are formed.

[0135] Like ion grouting for exfoliation promotion, this phosphorus ion grouting simultaneously can be carried out as that operation stage (H) besides (A) – (G) mentioned above. Also in this case, the mixed gas of PH3(5%)+H2 (95%) is plasma-ized, the phosphorus ion and hydrogen ion which were generated by that cause are accelerated, and it leads to a substrate, without minding a mass spectrograph. If it does so, even if it is the same acceleration voltage, while the

phosphorus ion with heavy mass stops at the polycrystalline silicon layer by the side of the upper layer, the hydrogen ion with light mass will be driven in more deeply, and it will reach to a detached core 120.

[0136] In addition, although gate electrode 150a functions as the mask pattern 201 of drawing 31, or the mask pattern 202 of drawing 32 similarly in this case, according to acceleration voltage, a mask layer can be further prepared on gate electrode 150a.

[0137] Moreover, although the operation stage like the above-mentioned ion grouting for exfoliation promotion (G) and (H) were as simultaneous as impurity ion grouting to the source in a process 5 and a process 6, and a drain field, they may be separately performed before and behind that.

[0138] (Process 7) As shown in drawing 14, an interlayer insulation film 154 is formed and Electrodes 152a-152d are alternatively formed after contact hole formation.

[0139] Thus, TFT of the formed CMOS structure corresponds to the transferred layer (thin film device layer) 140 in drawing 2 - drawing 6. In addition, a protective coat may be formed on an interlayer insulation film 154.

[0140] (Process 8) As shown in drawing 15, the epoxy resin layer 160 as a glue line is formed on TFT of a CMOS configuration, next TFT is stuck on the imprint object (for example, soda glass substrate) 180 through the epoxy resin layer 160. Then, heat is applied, an epoxy resin is stiffened and the imprint object 180 and TFT are pasted up (junction).

[0141] In addition, the photopolymer resin which is ultraviolet curing mold adhesives is sufficient as a glue line 160. In this case, ultraviolet rays are irradiated from the imprint object [not heat but] 180 side, and a polymer is stiffened.

[0142] (Process 9) As shown in drawing 16, Xe-Cl excimer laser light is irradiated from the rear face of the translucency substrate 100, for example. This produces and cheats out of exfoliation in the inside of the layer of a detached core 120, and/or an interface.

[0143] (Process 10) A substrate 100 is torn off as shown in drawing 17.

[0144] (Process 11) Finally etching removes a detached core 120. It means that TFT of a CMOS configuration had been imprinted by the imprint object 180 by this as shown in drawing 18.

[0145] <The gestalt of the 2nd operation>, next the gestalt of operation of the 2nd of this invention are explained with reference to drawing 33 - drawing 35. In addition, the gestalt of this 2nd operation imprints twice the transferred layer 140 which consists of thin film device layers, and, in addition to the process of drawing 1 of the gestalt of the 1st operation - drawing 6, the process of drawing 33 - drawing 35 is added.

[0146] Here, with the gestalt of this 2nd operation, the detached core 120 shown in drawing 2 - drawing 5 is called the 1st detached core. Moreover, with the gestalt of this 2nd operation, the glue line 160 of drawing 3 - drawing 6 is called the 2nd detached core. Furthermore, with the gestalt of this 2nd operation, the imprint object 180 of drawing 3 - drawing 6 is called a primary imprint object. Therefore, according to the gestalt of this 2nd operation, in the phase which the process of drawing 6 ended, it means that the transferred layer 140 had been imprinted by the primary imprint object 180 through the 2nd detached core 160.

[0147] With the gestalt of the 2nd operation here, the quality of the material of the 2nd detached core 160 can use the thing of the same quality of the material not only as thermofusion nature adhesives and water-soluble adhesives but the 1st detached core 120. In order to make easy exfoliation by this 2nd detached core 160 at this time, the ion implantation which was mentioned above and which was explained with the gestalt of the 1st operation can be performed.

[0148] More nearly hereafter, the additional processing of drawing 33 carried out after the process of drawing 6 - drawing 35 explains 1-3.

[0149] As [additional processing is shown in drawing 33 following the process of 1] drawing 6, the secondary imprint layer 200 is pasted up on the inferior surface of tongue (exposure) of the thin film device layer 140 through a glue line 190.

[0150] As a suitable example of the adhesives which constitute a glue line 190, various hardening mold adhesives, such as photo-curing mold adhesives, such as reaction hardening mold adhesives, heat-curing mold adhesives, and ultraviolet curing mold adhesives, and aversion hardening mold adhesives, are mentioned. As a presentation of adhesives, what kind of thing is

sufficient as an epoxy system, an acrylate system, a silicone system, etc., for example.

Formation of such a glue line 190 is made for example, by the applying method.

[0151] After applying hardening mold adhesives to the inferior surface of tongue of the transferred layer (thin film device layer) 140 and joining the secondary imprint object 200 further when using said hardening mold adhesives for example, said hardening mold adhesives are stiffened by the hardening approach according to the property of hardening mold adhesives, and the transferred layer (thin film device layer) 140 and the secondary imprint object 200 are pasted up, and it fixes.

[0152] When adhesives are photo-curing molds, light is preferably irradiated from the outside of the secondary imprint object 200 of light transmission nature. As long as it uses as adhesives photo-curing mold adhesives, such as an ultraviolet curing mold which cannot affect a thin film device layer easily, an optical exposure may be carried out from the primary imprint object 180 side of light transmission nature, or primary [of light transmission nature] and the both sides of the secondary imprint object 180,200.

[0153] In addition, unlike illustration, a glue line 190 may be formed in the secondary imprint object 200 side, and the transferred layer (thin film device layer) 140 may be pasted up on it. In addition, when secondary imprint object 200 the very thing has an adhesion function, for example, formation of a glue line 190 may be omitted.

[0154] although not limited especially as a secondary imprint object 200 — a substrate (plate) — especially a transparency substrate is mentioned. In addition, such a substrate may be monotonous or may be a curve plate.

[0155] Moreover, compared with said substrate 100, properties, such as thermal resistance and corrosion resistance, may be inferior in the secondary imprint object 200. It is because the reason forms the transferred layer (thin film device layer) 140 in a substrate 100 side in this invention, and imprints the transferred layer (thin film device layer) 140 on the secondary imprint object 200 after that, so it does not depend on the temperature conditions in the case of formation of the transferred layer (thin film device layer) 140 etc. for the property required of the secondary imprint object 200, especially thermal resistance. This point is the same also about the primary imprint object 180.

[0156] Therefore, when the maximum temperature in the case of formation of the transferred layer 140 is set to Tmax, a glass transition point (Tg) or softening temperature can use the following [Tmax] as a component of primary and the secondary imprint object 180,200. For example, a glass transition point (Tg) or softening temperature can constitute more preferably primary and 800 degrees C or less of 500 degrees C or less of secondary imprint objects 180,200 from an ingredient 320 degrees C or less still more preferably.

[0157] Moreover, although what has a certain amount of ** (reinforcement) as a mechanical property of primary and the secondary imprint object 180,200 is desirable, you may have flexibility and elasticity.

[0158] As a component of such primary and the secondary imprint object 180,200, various synthetic resin or various glass material are mentioned, and various synthetic resin and the usual cheap glass material (low melting point) are desirable especially.

[0159] As synthetic resin, any of thermoplastics and thermosetting resin are sufficient. For example, polyethylene, a polo propylene, an ethylene-pre pyrene copolymer, Polyolefines, such as an ethylene-vinylacetate copolymer (EVA), annular polyolefine, Denaturation polyolefine, a polyvinyl chloride, a polyvinylidene chloride, polystyrene, A polyamide, polyimide, polyamidoimide, a polycarbonate, Polly (4-methyl BENTEN -1), An ionomer, acrylic resin, polymethylmethacrylate, an acrylic-styrene copolymer (AS resin), Butadiene Styrene, a polio copolymer (EVOH), polyethylene terephthalate (PET), Polyester, such as polyp CHIREN terephthalate (PBT) and PURISHI clo hexane terephthalate (PCT), A polyether, a polyether ketone (PEK), a polyether ether ketone (PEEK), Polyether imide, polyacetal (POM), polyphenylene oxide, Denaturation polyphenylene oxide, polyarylate, aromatic polyester (liquid crystal polymer), Polytetrafluoroethylene, polyvinylidene fluoride, other fluorine system resin, A styrene system, a polyolefine system, a polyvinyl chloride system, a polyurethane system, Various thermoplastic elastomer, such as a fluororubber system and a chlorinated polyethylene system, EBOKISHI

resin, phenol resin, a urea resin, melamine resin, unsaturated polyester, The copolymer which is mainly concerned with these, a blend object, a polymer alloy, etc. are mentioned, and silicone resin, polyurethane, etc. can be used combining 1 of sorts of these, and two sorts or more (as a layered product for example, more than two-layer).

[0160] As glass material, silicic-acid glass (quartz glass), silicic-acid alkali glass, soda lime glass, potash lime glass, lead (alkali) glass, barium glass, borosilicate glass, etc. are mentioned, for example. Among these, compared with silicic-acid glass, the melting point is low, and shaping and processing are also comparatively easy the melting point, and, moreover, things other than silicic-acid glass have it, and are desirable. [cheap]

[0161] When using what consisted of synthetic resin as a secondary imprint object 200, while being able to fabricate the large-scale secondary imprint object 200 in one, even if it is complicated configurations, such as what has a curve side and irregularity, it can manufacture easily, and the various advantages that ingredient cost and a manufacturing cost are also cheap can be enjoyed. Therefore, use of synthetic resin is advantageous when manufacturing a large-sized and cheap device (for example, liquid crystal display).

[0162] In addition, the secondary imprint object 200 may constitute some devices like what constitutes the device which became independent in itself like a liquid crystal cell, a color filter and an electrode layer, a dielectric layer, an insulating layer, and a semiconductor device.

[0163] Furthermore, primary and the secondary imprint objects 180,200 may be matter, such as a metal, ceramics, a stone, and wood paper, and may be on the front face of the structures, such as a wall, a column, head lining, and a windowpane, further on the field of the arbitration which constitutes a certain article (superiors of the front-face top of the field top of a clock, and an air-conditioner, and a printed circuit board).

[0164] As [additional processing is shown in 2], next drawing 34, thermofusion of the thermofusion nature glue line 160 which is the 2nd detached core is heated and carried out. Consequently, since the adhesive strength of the thermofusion nature glue line 160 becomes weaker, it can be made to secede from the primary imprint object 180 by the thin film device layer 140. In addition, this primary imprint object 180 can be repeated and reused by removing the thermofusion nature adhesives adhering to the primary imprint object 180.

[0165] What is necessary is just to dip preferably the field which contains the 2nd detached core 160 at least in pure water that what is necessary is just to make water contact, when the water-soluble adhesives mentioned above as the 2nd detached core 160 are used. What is necessary is just to contact the field which contains the 2nd detached core 160 at least to an organic solvent, when the organic solvent melting nature adhesives mentioned above as the 2nd detached core 160 are used. the field which contains the 2nd detached core 160 at least when the adhesives which present an exfoliation operation by heating or UV irradiation mentioned above as the 2nd detached core 160 are used — other layers — minding — heating — or what is necessary is just to carry out UV irradiation Moreover, when an ablation layer is used like the 1st detached core 120 as the 2nd detached core, the 2nd detached core 160 is made to produce an exfoliation phenomenon by optical exposure. That exfoliation is promoted by the effectiveness of impregnation ion at this time.

[0166] As [additional processing is shown in drawing 35 by removing the 2nd detached core 160 which adhered to the front face of the thin film device layer 140 at the 3] last, the thin film device layer 140 imprinted by the secondary imprint object 200 can be obtained. Here, the laminating relation of the thin film device layer 140 to this secondary imprint object 200 becomes the same as the laminating relation of the thin film device layer 140 to the original substrate 100, as shown in drawing 2.

[0167] The imprint to the secondary imprint object 200 of the transferred layer (thin film device layer) 140 is completed through each above process. Then, conductive layers, such as removal of SiO₂ film which adjoins the transferred layer (thin film device layer) 140, and wiring of a up to [the transferred layer 140], formation of a desired protective coat, etc. can also be performed.

[0168] With the gestalt of the 2nd operation, transferred layer (thin film device layer) 140 the very thing which is an exfoliated object is not exfoliated directly. In order to dissociate in the 1st detached core 120 and the 2nd detached core 160 and to imprint on the secondary imprint

object 200, Irrespective of the property of a dissociated object (transferred layer 140), conditions, etc., easily and certainly, it can imprint to homogeneity, there is also no damage to the dissociated object (transferred layer 140) in accordance with separation actuation, and the high dependability of the transferred layer 140 can be maintained.

[0169] If the technique explained with the <gestalt of the 3rd operation> above-mentioned 1st and the gestalt of the 2nd operation is used, the microcomputer constituted using the thin film device as shown in drawing 19 (a), for example can be formed on a desired substrate.

[0170] In drawing 19 (a), the solar battery 340 possessing the PIN junction of an amorphous silicon for supplying the supply voltage of CPU300, RAM320 and the I/O circuits 360 where the thin film device was used and the circuit was constituted, and these circuits is carried on the flexible substrate 182 which consists of plastics etc.

[0171] Since the microcomputer of drawing 19 (a) is formed on the flexible substrate, as shown in drawing 19 (b), since it is lightweight, it has strongly the description that it is strong also to fall in bending.

[0172] The gestalt of <gestalt of the 4th operation> book operation explains the example of the manufacture process in the case of creating the liquid crystal display of the active-matrix mold using a active-matrix substrate as shown in drawing 20 and drawing 21 using the imprint technique of an above-mentioned thin film device.

[0173] (Configuration of a liquid crystal display) As shown in drawing 20, the liquid crystal display of a active-matrix mold possesses the sources 400 of the illumination light, such as a back light, a polarizing plate 420, the active-matrix substrate 440, liquid crystal 460, the opposite substrate 480, and a polarizing plate 500.

[0174] In addition, if it constitutes as a reflective mold liquid crystal panel which replaced with the source 400 of the illumination light, and adopted the reflecting plate when using a flexible substrate like plastic film for the active-matrix substrate 440 and the opposite substrate 480 of this invention, there is flexibility and a lightweight active matrix liquid crystal panel strong against an impact and can be realized. In addition, when a pixel electrode is formed with a metal, a reflecting plate and a polarizing plate 420 become unnecessary.

[0175] The active-matrix substrate 440 used with the gestalt of this operation arranges TFT in the pixel section 442, and is a driver built-in active-matrix substrate in which the driver circuit (a scanning-line driver and data-line driver) 444 was carried further.

[0176] The sectional view of the important section of this active matrix liquid crystal display is shown in drawing 21, and the circuitry of the important section of a liquid crystal display is shown in drawing 22.

[0177] As shown in drawing 22, the gate is connected to the gate line G1, one side of a source drain is connected to the data line D1, and the pixel section 442 contains TFT (M1) by which another side of a source drain was connected to liquid crystal 460, and liquid crystal 460.

[0178] Moreover, the driver section 444 is constituted including TFT (M2) formed of the same process as TFT (M1) of the pixel section.

[0179] As shown in the left-hand side of drawing 21, TFT (M1) in the pixel section 442 is constituted including the source drain layers 1100a and 1100b, channel 1100e, gate-dielectric-film 1200a, gate electrode 1300a, an insulator layer 1500, and the source drain electrodes 1400a and 1400b.

[0180] In addition, a reference number 1700 is a pixel electrode and a reference number 1702 shows the field (electrical-potential-difference impression field to liquid crystal) where the pixel electrode 1700 impresses an electrical potential difference to liquid crystal 460. The orientation film is omitted among drawing. The pixel electrode 1700 is constituted by metals (in the case of the liquid crystal panel of a reflective mold), such as ITO (in the case of the liquid crystal panel of a light transmission mold), or aluminum. Moreover, in drawing 21, in the electrical-potential-difference impression field 1702 to liquid crystal, although the substrate insulator layer 1000 under the pixel electrode 1700 (interlayer) is removed completely, it is not necessarily limited to this, and since the substrate insulator layer (interlayer) 1000 is thin, when not becoming the hindrance of the electrical-potential-difference impression to liquid crystal, you may leave.

[0181] Moreover, as shown in the right-hand side of drawing 21, TFT (M2) which constitutes the

driver section 444 is constituted including the source, the drain layers 1100c and 1100d, channel 1100f, gate-dielectric-film 1200b, gate electrode 1300b, an insulator layer 1500, and the source drain electrodes 1400c and 1400d.

[0182] In addition, in drawing 21, a reference number 480 is for example, an opposite substrate (for example, soda glass substrate), and a reference number 482 is a common electrode.

Moreover, a reference number 1000 is SiO₂ film, a reference number 1600 is an interlayer insulation film (for example, SiO₂ film), and a reference number 1800 is a glue line. Moreover, a reference number 1900 is a substrate (imprint object) which consists for example, of a soda glass substrate.

[0183] (Manufacture process of a liquid crystal display) The manufacture process of the liquid crystal display of drawing 21 is hereafter explained with reference to drawing 23 – drawing 27.

[0184] First, it forms through the same manufacture process as drawing 8 – drawing 18 on the substrate (for example, quartz substrate) 3000 which it is reliable in TFT (M1, M2) like drawing 23, and penetrates laser light, and a protective coat 1600 is constituted. In addition, in drawing 23, a reference number 3100 is a detached core (laser absorption layer) into which the ion for exfoliation promotion is poured. Moreover, in drawing 23, both TFT(s) (M1, M2) are taken as MOSFET of n mold. However, it is good also as not the thing limited to this but MOSFET of p mold, and CMOS structure.

[0185] Next, as shown in drawing 24, a protective coat 1600 and the substrate insulator layer 1000 are etched alternatively, and openings 4000 and 4200 are formed alternatively. These two openings are formed in coincidence using a common etching process. In addition, although the substrate insulator layer (interlayer) 1000 is completely removed in opening 4200 in drawing 24, it is not necessarily limited to this, and since the substrate insulator layer (interlayer) 1000 is thin, when not becoming the hindrance of the electrical-potential-difference impression to liquid crystal, you may leave.

[0186] Next, as shown in drawing 25, the pixel electrode 1700 which consists of metals, such as ITO film or aluminum, is formed. In using the ITO film, it becomes the liquid crystal panel of a transparency mold, and in using metals, such as aluminum, it becomes the liquid crystal panel of a reflective mold. Next, as shown in drawing 26, a substrate 1900 is joined through a glue line 1800 (adhesion).

[0187] Next, excimer laser light is irradiated from the rear face of a substrate 3000, the operation by the ion for exfoliation promotion is also used, and a detached core 120 is made to produce an exfoliation phenomenon, as shown in drawing 26. Then, a substrate 3000 is torn off. Since the force like ** is not required for tearing off at this time, a mechanical damage does not arise in TFT.

[0188] Next, a detached core (laser absorption layer) 3100 is removed. Thereby, the active-matrix substrate 440 as shown in drawing 27 is completed. It has exposed and the electric connection with liquid crystal is possible for the base (field of a reference number 1702) of the pixel electrode 1700. Then, the orientation film is formed in the front face of the insulator layer (interlayers, such as SiO₂) 1000 of the active-matrix substrate 440, and pixel electrode 1702 front face, and orientation processing is performed. The orientation film is omitted in drawing 27.

[0189] And the pixel electrode 1709 and the common electrode which counters are further formed in the front face, the opposite substrate 480 and the active MATORIKU substrate 440 of drawing 21 with which orientation processing of the front face was carried out are closed with a sealing agent (sealant), liquid crystal is enclosed among both substrates, and a liquid crystal display as shown in drawing 21 is completed.

[0190] The gestalt of operation of the 5th of this invention is shown in <gestalt of the 5th operation> drawing 28.

[0191] With the gestalt of this operation, multiple-times activation of the imprint approach of an above-mentioned thin film device is carried out, on a larger substrate (imprint object) than the substrate of an imprinting agency, two or more patterns containing a thin film device are imprinted, and, finally a large-scale active-matrix substrate is formed.

[0192] That is, on the big substrate 7000, the imprint of multiple times is performed and the pixel

sections 7100a-7100P are formed. TFT and wiring are formed in the pixel section as surrounded and shown to the drawing 28 bottom by the alternate long and short dash line. In drawing 28, a reference number 7210 is the scanning line, a reference number 7200 is a signal line and a reference number 7230 is [a reference number 7220 is a gate electrode and] a pixel electrode. [0193] The large-scale active-matrix substrate carrying a reliable thin film device can be created by repeating and using a reliable substrate or carrying out multiple-times activation of the imprint of a thin film pattern using two or more 1st substrates.

[0194] The gestalt of operation of the 6th of <gestalt of the 6th operation> this invention is shown in drawing 29.

[0195] The description of the gestalt of this operation is imprinting two or more patterns containing the thin film device (that is, thin film device with which minimum line width's differs) with which multiple-times activation of the imprint approach of an above-mentioned thin film device is carried out, and the design Ruhr's (that is, design rule's when carrying out a pattern design's) differs on a bigger substrate than the substrate top of an imprinting agency.

[0196] In drawing 29, the driver circuit (8000-8032) created in the more detailed manufacture process rather than the pixel section (7100a-7100p) is created around the substrate 6000 by the imprint of multiple times in the active-matrix substrate of driver loading.

[0197] Since the shift register which constitutes a driver circuit carries out actuation of a logic level to the bottom of a low battery, rather than Pixel TFT, pressure-proofing may be low, and as it is therefore set to TFT more detailed than Pixel TFT, high integration can be attained.

[0198] According to the gestalt of this operation, two or more circuits where design Ruhr level differs (that is, manufacture processes differ) are realizable on one substrate. In addition, since high pressure-proofing is the need like Pixel TFT, a sampling means (thin film transistor M2 of drawing 22) to sample a data signal by control of a shift register may be formed in the same process as Pixel TFT / same design Ruhr.

[0199]

[Example] Next, the concrete example of this invention is explained.

[0200] (Example 1) The quartz substrate (1630 degrees C, a strain point: softening temperature : 1070 degrees C, permeability of excimer laser : about 100%) with a 50mm[50mm by] x thickness of 1.1mm was prepared, and the amorphous silicon (a-Si) film was formed in one side of this quartz substrate as a detached core (laser beam absorption layer) with the low voltage CVD method (Si₂H₆ gas, 425 degrees C). The thickness of a detached core was 100nm.

[0201] Next, it is SiO₂ as an interlayer on a detached core. The film was formed with the ECR-CVD method (SiH₄+O₂ gas, 100 degrees C). An interlayer's thickness was 200nm.

[0202] Next, the amorphous silicon film of 50nm of thickness was formed as a transferred layer on the interlayer with the low voltage CVD method (Si₂H₆ gas, 425 degrees C), a laser beam (wavelength of 308nm) is irradiated, this amorphous silicon film was crystallized, and it considered as the polish recon film. Then, to this polish recon film, predetermined pattern NINGU was given and the field used as the source drain channel of a thin film transistor was formed. then, a TEOS-CVD method (SiH₄+O₂ gas) — 1200nm gate dielectric film SiO₂ after forming, form a gate electrode (structure where laminating formation of the refractory metals, such as Mo, was carried out at polish recon), on gate dielectric film, and it carries out an ion implantation, using a gate electrode as a mask — self align —like (selfer line) — the source drain field was formed and the thin film transistor was formed. At this time, the hydrogen ion was poured into coincidence at the detached core. Then, the electrode connected to a source drain field and wiring, and wiring which leads to a gate electrode are formed if needed. Although aluminum is used for these electrodes and wiring, it is not limited to this. Moreover, when worrying about melting of aluminum by the laser radiation of a back process, a high-melting metal (what is not fused by the laser radiation of a back process) may be used rather than aluminum.

[0203] Next, ultraviolet curing mold adhesives were applied on said thin film transistor (thickness: 100 micrometers), further, after joining a transparent large-sized glass substrate (soda glass, softening-temperature:740 degree C, a strain point: 511 degrees C) with a 300mm[200mm by] x thickness of 1.1mm to the paint film as an imprint object, ultraviolet rays were irradiated from the glass substrate side, adhesives were stiffened, and adhesion immobilization of these was

carried out.

[0204] Next, Xe-Cl excimer laser (wavelength: 308nm) was irradiated from the quartz substrate side, and the detached core was made to produce exfoliation (exfoliation in a layer, and interfacial peeling) by carrying out the beam scan shown after drawing 31. The irradiated energy density of Xe-Cl excimer laser was 250 mJ/cm², and irradiation time was 20ns. In addition, the exposure of excimer laser had a spot beam exposure and the Rhine beam exposure, and when it was a spot beam exposure, the spot exposure was carried out to the predetermined unit field (for example, 8mmx8mm), and it irradiated this spot exposure, carrying out a beam scan so that the exposure field of each time may not lap (it does not lap all around like). Moreover, in the Rhine beam exposure, it irradiated, carrying out the beam scan of the predetermined unit field (for example, 378mmx0.1mm and 378mmx0.3mm (field where, as for these, 90% or more of energy is obtained)) similarly, so that the exposure field of each time may not lap.

[0205] Then, the quartz substrate and the glass substrate (imprint object) were torn off in the detached core, and the thin film transistor and interlayer who were formed on the quartz substrate were imprinted to the glass substrate side.

[0206] Then, etching, washing, or those combination removed the detached core adhering to the front face of the middle class by the side of a glass substrate. Moreover, processing with the same said of a quartz substrate was performed, and the reuse was presented.

[0207] In addition, if the glass substrate used as an imprint object is a bigger substrate than a quartz substrate, the imprint to a glass substrate from a quartz substrate like this example can be repeatedly carried out to a superficially different field, and many thin film transistors can be formed on a glass substrate from the number of the thin film transistors which can be formed in a quartz substrate. Furthermore, on a glass substrate, a laminating can be carried out repeatedly and more thin film transistors can be formed similarly.

[0208] (Example 2) a detached core — a detached core formation process — H (hydrogen) — 20at(s)% — the thin film transistor was imprinted like the example 1 except having considered as the amorphous silicon film to contain.

[0209] In addition, adjustment of the amount of H in the amorphous silicon film was performed by setting up suitably the conditions at the time of membrane formation by the low voltage CVD method.

[0210] (Example 3) The thin film transistor was imprinted like the example 1 except having used the detached core as the ceramic thin film (presentation—bTiO₃, thickness: 200nm) formed with the sol-gel method with the spin coat.

[0211] (Example 4) The thin film transistor was imprinted like the example 1 except having used the detached core as the ceramic thin film (presentation: BaTiO₃, thickness:400nm) formed by sputtering.

[0212] (Example 5) The thin film transistor was imprinted like the example 1 except having used the detached core as the ceramic thin film (presentation :P b (Zr Ti)O₃ (PZT) and thickness: 50nm) formed by the laser-ablation method.

[0213] (Example 6) The thin film transistor was imprinted like the example 1 except having used the detached core as the polyimide film (thickness: 200nm) formed with the spin coat.

[0214] (Example 7) The thin film transistor was imprinted like the example 1 except having used the detached core as the polyphenylene sulfide film (thickness: 200nm) formed with the spin coat.

[0215] (Example 8) The thin film transistor was imprinted like the example 1 except having used the detached core as aluminum layer (thickness: 300nm) formed by sputtering.

[0216] (Example 9) As an exposure light, the thin film transistor was imprinted like the example 2 except having used Kr-F excimer laser (wavelength: 248nm). In addition, the energy density of the irradiated laser was 250 mJ/cm², and irradiation time was 20ns.

[0217] (Example 10) As an exposure light, the thin film transistor was imprinted like the example 2 except having used Nd-YAIG laser (wavelength: 1068nm). In addition, the energy density of the irradiated laser was 400 mJ/cm², and irradiation time was 20ns.

[0218] (Example 11) The thin film transistor was imprinted like the example 1 except having considered as the thin film transistor of the polish recon film (80nm of thickness) by elevated-

temperature process 1000 degree C as a transferred layer.

[0219] (Example 12) As an imprint object, the thin film transistor was imprinted like the example 1 except having used the transparency substrate made from a polycarbonate (glass transition point: 130 degrees C).

[0220] (Example 13) As an imprint object, the thin film transistor was imprinted like the example 2 except having used the transparency substrate made of an AS resin (glass transition point: 70–90 degrees C).

[0221] (Example 14) As an imprint object, the thin film transistor was imprinted like the example 3 except having used the transparency substrate made from polymethylmethacrylate (glass transition point: 70–90 degrees C).

[0222] (Example 15) As an imprint object, the thin film transistor was imprinted like the example 5 except having used the transparency substrate made from polyethylene terephthalate (glass transition point: 67 degrees C).

[0223] (Example 16) As an imprint object, the thin film transistor was imprinted like the example 6 except having used the transparency substrate made from high density polyethylene (glass transition point: 77–90 degrees C).

(Example 17) As an imprint object, the thin film transistor was imprinted like the example 9 except having used the transparency substrate made from a polyamide (glass transition point: 145 degrees C).

[0224] (Example 18) As an imprint object, the thin film transistor was imprinted like the example 10 except having used the transparency substrate made of an epoxy resin (glass transition point: 120 degrees C).

[0225] (Example 19) As an imprint object, the thin film transistor was imprinted like the example 11 except having used the transparency substrate made from polymethylmethacrylate (glass transition point: 70–90 degrees C).

[0226] About examples 1–19, when the condition of the imprinted thin film transistor was guessed the ** view under the naked eye and the microscope, respectively, all had neither a defect nor nonuniformity and the imprint was made by homogeneity.

[0227] As stated above, when using the imprint technique of this invention, it was able to become possible to imprint a thin film device (transferred layer) to various imprint objects, especially exfoliation of a substrate required for an imprint was able to be performed reasonable, without acting too much force. or [that a thin film cannot be formed directly by this] — or it can be formed by imprint also to what consisted of an ingredient unsuitable for forming, an ingredient with easy shaping, a cheap ingredient, etc., the large-sized body which is hard to move.

[0228] That in which properties, such as thermal resistance and corrosion resistance, are inferior compared with various synthetic resin or a substrate ingredient like glass material with the low melting point can be used especially for an imprint object, therefore — for example, it can face manufacturing the liquid crystal display in which the thin film transistor (especially poly-Si TFT) was formed on the transparency substrate, and a large-sized and cheap liquid crystal display can be easily manufactured now as an imprint object as a substrate using the quartz-glass substrate which is excellent in thermal resistance by using a transparency substrate of the ingredient which it is cheap and processing tends to carry out like glass material with low various synthetic resin and melting point. Such an advantage is the same also about manufacture of not only a liquid crystal display but other devices.

[0229] Moreover, although the above advantages are enjoyed, since a transferred layer like a functional thin film can be formed to a heat-resistant high substrate like a reliable substrate, especially a quartz-glass substrate and patterning can be carried out further, a reliable functional thin film can be formed on an imprint object irrespective of the material property of an imprint object.

[0230] Moreover, although such a reliable substrate is expensive, it is also possible to reuse it and, therefore, a manufacturing cost is also reduced.

[0231]

[Translation done.]

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TECHNICAL FIELD

[Field of the Invention] This invention relates to the exfoliation approach of a thin film device, the imprint approach of a thin film device, a thin film device, a active-matrix substrate, and a liquid crystal display.

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PRIOR ART

[Background of the Invention] For example, it faces manufacturing the liquid crystal display using a thin film transistor (TFT), and passes through the process which forms a thin film transistor by CVD etc. on a substrate. Since the process which forms a thin film transistor on a substrate is accompanied by high temperature processing, a substrate needs to use what has the high thing, i.e., the softening temperature, and the high melting point of the quality of the material which is excellent in thermal resistance. Therefore, in current, quartz glass is used as a substrate which bears the temperature of about 1000 degrees C, and heat-resisting glass is used as a substrate which bears the temperature around 500 degrees C.

[0003] As mentioned above, the substrate carrying a thin film device must satisfy the conditions for manufacturing those thin film devices. That is, it is determined that the substrate to be used will surely fulfill the manufacture conditions of the device carried.

[0004] However, when its attention is paid only to the phase after the substrate carrying thin film devices, such as TFT, is completed, above-mentioned "substrate" is not sometimes necessarily desirable.

[0005] For example, although a quartz substrate, a heat-resisting glass substrate, etc. are used as mentioned above when passing through the manufacture process accompanied by high temperature processing, these are very expensive, therefore cause the rise of a product price.

[0006] Moreover, a glass substrate has the property for it to be heavy and to be easy to be divided. Although what cannot break easily even if it is cheap as much as possible, it is light and it bears and drops also on deformation of some with the liquid crystal display used for portable electronic devices, such as a palmtop computer and a portable telephone, is desirable, actually, a glass substrate is heavy, and is weak to deformation, and it is common that there is fear of destruction by fall.

[0007] That is, it was very difficult for a slot to be between the desirable properties required of the constraint which comes from manufacture conditions, and a product, and to satisfy the conditions and property of these both sides to it.

[0008] Then, an applicant for this patent has proposed the technique of exfoliating from the 1st substrate and making the 2nd substrate imprinting this thin film device, after forming a thin film device on the 1st substrate in the conventional process (Japanese Patent Application No. No. 225643 [eight to]). For this reason, the detached core is formed between the 1st substrate and the thin film device which is a transferred layer. The thin film device which is a transferred layer is made to exfoliate from the 1st substrate, and this transferred layer is made to imprint to a 2nd substrate side by irradiating light at this detached core.

[Translation done.]

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] According to the experiment of this invention person, when making a thin film device exfoliate from the 1st substrate, it was discovered that an exfoliation phenomenon may not fully arise in a detached core only by irradiating light at a detached core.

[0010] And it became clear that it was [of this invention person] dependent on the property of a detached core wholeheartedly whether it is easy to produce this exfoliation phenomenon according to research.

[0011] Furthermore, the technical problem that it will differ mutually had the laminating relation of the transferred layer to the 1st substrate used when manufacturing a transferred layer, and the laminating relation of the transferred layer to the 2nd substrate which is the imprint place of the transferred layer.

[0012] Then, this invention is to offer the thin film device, active-matrix substrate, and liquid crystal display which use it for the exfoliation approach list of a thin film device compensate [list] that it will be in the condition that a detached core tends to exfoliate, and it was made to make a thin film device exfoliate easily from a substrate, and are manufactured in front of the process which makes a detached core produce an exfoliation phenomenon in exfoliation.

[0013] Other purposes of this invention are to offer the imprint approach of the thin film device which can make in agreement the laminating relation of the transferred layer to the substrate used at the time of manufacture of a transferred layer, and the laminating relation of the transferred layer to the imprint object which is the imprint place of the transferred layer.

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MEANS

[Means for Solving the Problem] The 1st process at which invention according to claim 1 forms a detached core on a substrate, and the 2nd process which forms a thin film device on said detached core, An exfoliation phenomenon is produced in the inside of the layer of said detached core, and/or an interface, and it is characterized by preparing like ion grouting which pours ion into said detached core before said 3rd process in the exfoliation approach of a thin film device of having the 3rd process which makes said substrate exfoliating from said detached core.

[0015] The detached core which has the property which absorbs light that the dependability in device manufacture is high, on substrates, such as a quartz substrate, is prepared, for example, and thin film devices, such as TFT, are formed on the substrate. It joins to the imprint object of a request of a thin film device through the glue line preferably next. Light is irradiated after that at a detached core, and it produces and cheats out of an exfoliation phenomenon in the detached core. Thereby, a thin film device can be made to exfoliate from a substrate by applying the force to a substrate.

[0016] The exfoliation phenomenon of the detached core in an exfoliation process can become remarkable, and a thin film device can be made to exfoliate from a substrate certainly by pouring ion into a detached core in front of an exfoliation process at this time.

[0017] Here, by pouring ion into a detached core beforehand, the operation defined as either of claims 2–5 is made, and the exfoliation phenomenon of a detached core becomes remarkable.

[0018] According to claim 2, the process by which said ion poured into said detached core is gasified is included in said three processes. If the ion in a detached core is gasified, in a detached core, internal pressure will arise and the exfoliation phenomenon will be promoted.

[0019] In this case, light can be irradiated at a detached core and the ion for exfoliation can be made to gasify by that light, as shown in claim 3. If an optical exposure is carried out at this time [side / of a substrate / rear-face], the quantity of light by which optical incidence is carried out to a thin film device layer can be reduced, and degradation of that property can be prevented.

[0020] According to claim 4, like said ion grouting, association of the atom or molecule which constitutes said detached core with said ion is cut, and a damage is beforehand given to said detached core. Therefore, the exfoliation phenomenon in the detached core produced at a subsequent exfoliation process is promoted.

[0021] According to claim 5, like said ion grouting, the property of said detached core is changed with said ion, and the adhesion of said detached core and said substrate is weakened beforehand. Therefore, the exfoliation phenomenon in the detached core produced at a subsequent exfoliation process is promoted.

[0022] Invention of claim 6 has a thin film transistor formation process for said 2nd process to form a thin film transistor in claim 1 thru/or either of 5, and said thin film transistor formation process is characterized by carrying out after said channel layer formation process like said ion grouting including a channel layer formation process.

[0023] A channel formation process turns into a high-temperature-processing process as compared with other processes. Therefore, it is because there is a possibility that ion may be emitted from a detached core at the time of subsequent high temperature processing when the

ion for exfoliation phenomenon promotion is poured in before that at the detached core.

[0024] Invention of claim 7 is characterized by carrying out said thin film transistor formation process after said channel pattern formation process like said ion grouting including a channel pattern formation process after said channel layer formation process in claim 6.

[0025] If the channel pattern is formed, even if it pours in the ion for exfoliation phenomenon promotion from a channel pattern side, the area of the channel pattern itself which can serve as a failure of the impregnation will decrease. Therefore, it becomes that it is easy to make ion reach to a detached core.

[0026] Invention of claim 8 is characterized by forming a mask among said channel layers on a channel field and the becoming field, and carrying out like said ion grouting in claims 6 or 7.

[0027] It is because there is a possibility that transistor characteristics may deteriorate when ion is poured into a channel field. In addition, the process which carries out the mask of the channel field and carries out an ion implantation may be before channel pattern formation or after formation.

[0028] In claim 9, said thin film transistor formation process is characterized by carrying out like said ion grouting by using said gate electrode as a mask after said channel pattern formation process including the process which forms gate dielectric film on this channel pattern, and the process which forms a gate electrode on this gate dielectric film in claim 7.

[0029] Since a gate electrode is formed in a channel and the location which counters, a gate electrode can be used also [field / channel] as a mask with which ion prevents pouring into a channel field. In addition, according to the acceleration voltage of ion, a mask may be further formed on a gate electrode.

[0030] Invention of claim 10 is characterized by pouring into coincidence the impurity ion driven into either [at least.] the source field in said channel pattern, or a drain field, and said ion which mass is lighter than it and is driven into said detached core like said ion grouting in claims 8 or 9.

[0031] If it carries out like this, it can be made to serve a double purpose like impurity ion grouting to the source and/or a drain field like ion grouting to a detached core. In addition, since mass is lighter than impurity ion, ion can reach to the detached core in a location deeper than the source and a drain field.

[0032] Invention of claim 11 is characterized by carrying out said thin film transistor formation process in front of said crystallization process like said ion grouting including the process which forms an amorphous silicon layer as said channel layer, and the crystallization process which carries out laser annealing of the account amorphous silicon layer of back to front, and is crystallized in claim 6.

[0033] Crystallinity is raised by the subsequent laser annealing process even if a damage should arise in a channel layer by operation like ion grouting.

[0034] Invention of claim 12 is characterized by said ion being a hydrogen ion in claim 1 thru/or either of 11.

[0035] If a hydrogen ion is poured into a detached core, it can be made to contribute to the operation shown in each of claims 2-4. Since mass is lighter than the source and the impurity ion (boron, Lynn, etc.) driven into a drain, especially the hydrogen ion also fits implementation of invention of claim 9. In addition, as ion which mainly produces gasification of claim 2, nitrogen ion etc. can be mentioned other than a hydrogen ion. Moreover, as ion which mainly produces the damage of claims 3 and 4, or an adhesion fall, Si ion etc. can be mentioned other than a hydrogen ion.

[0036] Invention of claim 13 is characterized by said ion grouting making process temperature of the process carried out behind less than 350 degrees C in claim 12.

[0037] Since it begins to escape from the hydrogen poured into the detached core by being heated by 350 degrees C or more, as for the process which needs the process temperature of 350 degrees C or more, it is as desirable as ion grouting to a detached core to carry out in front.

[0038] Invention of claim 14 defines the thin film device which uses the exfoliation approach of ** for claim 1 thru/or either of 13, exfoliates from said substrate, and changes. Since the

exfoliation from a detached core is easy for this thin film device, there is little mechanical pressure which acts at the time of exfoliation, it ends, and can lessen the defect depending on the magnitude of that load.

[0039] Invention of claim 15 is a active-matrix substrate with which the pixel section is constituted including the thin film transistor arranged in the shape of a matrix, and the pixel electrode connected to the end of the thin film transistor, and defines the active-matrix substrate manufactured by imprinting the thin film transistor of said pixel section using an approach according to claim 6 to 13.

[0040] This active-matrix substrate as well as invention of claim 13 can lessen a defect.

[0041] Invention of claim 16 defines the liquid crystal display manufactured using the active-matrix substrate according to claim 15.

[0042] Since the active-matrix substrate of claim 15 is used for this liquid crystal display, its defect as the whole liquid crystal display also decreases.

[0043] The imprint approach of the thin film device concerning invention of claim 17 The 1st process which forms the 1st detached core on a substrate, and the 2nd process which forms the transferred layer containing a thin film device on said 1st detached core, The 3rd process which forms the 2nd detached core which consists of water solubility or organic solvent melting nature adhesives on said transferred layer, It borders on said 1st detached core at the 4th process which joins a primary imprint object on said 2nd detached core. The 5th process which removes said substrate from said transferred layer, and the 6th process which joins a secondary imprint object to the inferior surface of tongue of said transferred layer, Said 2nd detached core is contacted to water or an organic solvent, and it has the 7th process which removes said primary imprint object from said transferred layer bordering on said 2nd detached core, and is characterized by imprinting said transferred layer containing said thin film device on a secondary imprint object.

[0044] After removing the 1st detached core and joining a secondary imprint object to the inferior surface of tongue from the inferior surface of tongue of a transferred layer, it is made to secede from a primary imprint object from a transferred layer bordering on the 2nd detached core according to invention of claim 17. If it carries out like this, a secondary imprint object will exist in the location in which the original substrate was located to a transferred layer, and the laminating relation of the transferred layer to the original substrate and the laminating relation of the transferred layer to a secondary imprint object are in agreement. here, since water-soluble adhesives or organic solvent melting nature adhesives is used as the 2nd detached core, the 2nd detached core is contacted to water or an organic solvent making it secede from a primary imprint object — being sufficient .

[0045] By the imprint approach of the thin film device concerning invention of claim 18, as the 2nd detached core under approach invention of claim 17, it replaces with the above-mentioned adhesives and the adhesives which can exfoliate by heating or ultraviolet rays are used.

[0046] In this case, if the 2nd detached core is contacted in the adhesives which can exfoliate by heating or ultraviolet rays making it secede from a primary imprint object, the laminating relation of the transferred layer to the original substrate and the laminating relation of the transferred layer to a secondary imprint object can be made in agreement like invention of claim 17.

[0047]

[Embodiment of the Invention] Next, the gestalt of operation of this invention is explained with reference to a drawing.

[0048] <Gestalt of the 1st operation> drawing 1 – drawing 6 are drawings for explaining the imprint approach of the thin film device which will be the requisite for this invention.

[0049] As shown in [process 1] drawing 1 , a detached core (light absorption layer) 120 is formed on a substrate 100.

[0050] Hereafter, a substrate 100 and a detached core 120 are explained.

[0051] ** What has the translucency which light may penetrate is used for the explanation substrate 100 about a substrate 100.

[0052] In this case, as for the permeability of light, it is desirable that it is 10% or more, and it is

more desirable that it is 50% or more. When this permeability is too low, attenuation (loss) of light becomes large and needs the big quantity of light by exfoliating a detached core 120.

[0053] Moreover, as for a substrate 100, it is desirable to consist of reliable ingredients, and it is desirable to consist of ingredients which were excellent in thermal resistance especially.

Although the reason has what process temperature becomes high depending on the class and formation approach (for example, about 350–1000 degrees C) in case it forms the transferred layer 140 and interlayer 142 who mention later, it is because the width of face of a setup of membrane formation conditions, such as the temperature condition, will spread even in such a case on the occasion of formation of the transferred layer 140 grade to a substrate 100 top if the substrate 100 is excellent in thermal resistance.

[0054] Therefore, a substrate 100 has a desirable consisting-of [the strain point]-ingredients more than Tmax thing, when the maximum temperature in the case of formation of the transferred layer 140 is set to Tmax. A thing 350 degrees C or more has a desirable strain point, and, specifically, the component of a substrate 100 has a more desirable thing 500 degrees C or more. As such a thing, the heat resisting glass of quartz glass, Corning 7059, and NEC glass OA-2 grade is mentioned, for example.

[0055] Moreover, although especially the thickness of a substrate 100 is not limited, it is desirable that it is about 0.1–5.0mm, and it is usually more desirable that it is about 0.5–1.5mm. If the thickness of a substrate 100 is too thin, a strong fall will be caused, and if too thick, when the permeability of a substrate 100 is low, it will become easy to produce attenuation of light. In addition, when the permeability of the light of a substrate 100 is high, the thickness may exceed said upper limit. In addition, as for the thickness of a substrate 100, it is desirable that it is uniform so that light can be irradiated at homogeneity.

[0056] ** The explanation detached core 120 of a detached core 120 is receiving any one or two or more operations of physical operations (light, heat, etc.), chemical operations (chemical reaction with a drug solution etc.), or mechanical works (hauling force, vibration, etc.), that bonding strength is decreased or extinguished and this urges separation of a substrate 100 to it through this detached core 120.

[0057] The light which it considers as this detached core 120, for example, is irradiated can be absorbed, and what has a property which produces exfoliation (henceforth "exfoliation in a layer" and "interfacial peeling") in the inside of that layer and/or an interface can be mentioned. What it arises that the bonding strength between the atoms of the matter which constitutes a detached core 120, or between molecules disappears or decreases, i.e., ablation, and results in the exfoliation in a layer and/or interfacial peeling by the exposure of light preferably is good.

[0058] Furthermore, a gas may be emitted by the exposure of light from a detached core 120, and the separation effectiveness may be discovered. That is, a detached core 120 absorbs light, it becomes a gas to the case where the component contained in the detached core 120 serves as a gas, and it is emitted for a moment, the steam is emitted, and it may contribute to separation.

[0059] In this invention, after forming the detached core 120 which has such a property, it is the description to pour in the ion for exfoliation promotion into a detached core 120, and, thereby, the exfoliation phenomenon in the detached core 120 in a subsequent process is promoted. Therefore, a class will not be asked if the exfoliation phenomenon by the physical operation, chemical operation, or mechanical work mentioned above is promoted as ion for exfoliation promotion.

[0060] Next, as a presentation of such a detached core 120, what is indicated by following A–E is mentioned, for example.

[0061] A. Amorphous silicon (a-Si)

Hydrogen (H) may contain in this amorphous silicon. In this case, as for the content of H, it is desirable that it is extent more than 2 atom %, and it is more desirable that it is 2 – 20 atom % extent. Thus, if specified quantity content of the hydrogen (H) is carried out, by making light an exposure behind, hydrogen will be emitted, internal pressure will occur in a detached core 120, and it will become the force in which it exfoliates an up-and-down thin film. The content of the hydrogen in an amorphous silicon (H) can be adjusted by setting up suitably conditions, such as

membrane formation conditions, for example, the gas presentation in CVD, gas pressure, a gas ambient atmosphere, a quantity of gas flow, temperature, substrate temperature, and injection power.

[0062] With the gestalt of this operation, the ion implantation of the hydrogen ion can be carried out as ion for exfoliation promotion at one after formation of an amorphous silicon layer of stages as hydrogen is made to contain in a detached core 120 according to this process condition and also being mentioned later. Thereby, the hydrogen more than a constant rate can be made to contain in an amorphous silicon layer, without being influenced by the process conditions of an amorphous silicon.

[0063] B. As various oxide ceramics, such as silicon oxide or a silicic-acid compound, titanium oxide or a titanic-acid compound, a zirconium dioxide or a zirconic acid compound, a lanthanum trioxide, or a lanthanum oxidation compound, ***** (ferroelectric), or semi-conductor silicon oxide, SiO, SiO₂, and Si₃O₂ are mentioned, and K₂SiO₃, Li₂SiO₃, CaSiO₃ and ZrSiO₄, and Na₂SiO₃ are mentioned as a silicic-acid compound, for example.

[0064] TiO, Ti₂O₃, and TiO₂ mention as titanium oxide — having — as a titanic-acid compound — BaTiO₄, BaTiO₃, Ba₂Ti₉O₂₀, BaTi₅O₁₁, and CaTiO₃, SrTiO₃, PbTiO₃, MgTiO₃, ZrTiO₂, SnTiO₄ and aluminum₂ — TiO₅ and FeTiO₃ are mentioned.

[0065] As a zirconium dioxide, ZrO₂ is mentioned and BaZrO₃, ZrSiO₄, PbZrO₃, MgZrO₃, and K₂ZrO₃ are mentioned as a zirconic acid compound, for example.

[0066] C. The ceramics or dielectrics (ferroelectric), such as PZT, PLZT, PLLZT, and PBZT D. As nitride-ceramics E. organic polymeric-materials organic polymeric materials, such as silicon nitride, nitriding aluminum, and titanium nitride — CH—, —CO— (ketone), —CONH— (amide), —NH— (imide), — As long as it is what has association (these association is cut by the exposure of light) of COO— (ester), —N=N— (azo), —CH=N— (CIF), etc., and the thing which has many these association especially, what kind of thing may be used. Moreover, organic polymeric materials may have aromatic hydrocarbon (1, two or more benzene rings, or condensed ring of those) in a constructive mood.

[0067] As an example of such organic polymeric materials, polyethylene, polyolefine like polypropylene, polyimide, a polyamide, polyester, polymethylmethacrylate (PMMA), polyphenylene sulfide (PPS), polyether sulphone (PES), an epoxy resin, etc. are raised.

[0068] F. As a metal metal, the alloy containing at least one of aluminum, Li, Ti, Mn, In, Sn, Y, La, Ce, Nd, Pr, Gd, Sm, or sorts of these is mentioned, for example.

[0069] Moreover, although the thickness of a detached core 120 changes with terms and conditions, such as a presentation of the exfoliation purpose or a detached core 120, lamination, and the formation approach, it is desirable that it is 1nm — about 20 micrometers, it is more desirable that it is 5nm — about 2 micrometers, and it is usually still more desirable [thickness] that it is 5nm — about 1 micrometer. While enlarging power (quantity of light) of light in order to secure the good detachability of a detached core 120 if the homogeneity of membrane formation is spoiled, nonuniformity may arise in exfoliation, when the thickness of a detached core 120 is too small, and thickness is too thick, in case a detached core 120 is removed behind, the activity takes time amount. In addition, as for the thickness of a detached core 120, it is desirable that it is uniform as much as possible.

[0070] Especially the formation approach of a detached core 120 is not limited, but is suitably chosen according to terms and conditions, such as a film presentation and thickness. For example, it CVD(s) (MOCVD and low voltage — CVD and ECR-CVD are included). Vacuum evaporation, molecular beam deposition (MB), sputtering, ion plating, The various gaseous-phase forming-membranes methods, such as PVD, electroplating, immersion plating (dipping), various plating, such as electroless deposition, and the Langmuir pro jet (LB) — law — The applying methods, such as a spin coat, a spray coat, and a roll coat, various print processes, a replica method, the ink jet method, a powder jet process, etc. are mentioned, and it can also form or more [of these] combining two.

[0071] For example, when the presentation of a detached core 120 is an amorphous silicon (a-Si), it is desirable to form membranes by CVD especially low voltage CVD, or plasma CVD.

[0072] Moreover, when a detached core 120 is constituted from ceramics by the sol-gel method,

or when it constitutes from organic polymeric materials, it is desirable the applying method and to form membranes with a spin coat especially.

[0073] As shown in [a process 2], next drawing 2, the transferred layer (thin film device layer) 140 is formed on a detached core 120. Although the detail after this process 2 is later explained with reference to drawing 8 – drawing 18, it is carrying out like ion grouting for exfoliation promotion to a detached core 120 with the gestalt of this operation in the middle of the process of drawing 8 – drawing 13.

[0074] The expanded sectional view of K part (part shown by surrounding with 1 dotted-line chain line in drawing 2) of this thin film device layer 140 is shown in the right-hand side of drawing 2. It is constituted including TFT (thin film transistor) formed on SiO₂ film (middle class) 142, and the thin film device layer 140 possesses the source and the drain layer 146 which this TFT introduced n mold impurity into the polish recon layer, and were formed, the channel layer 144, gate dielectric film 148, the gate electrode 150, an interlayer insulation film 154, and the electrode 152 that consists of aluminum so that it may be illustrated.

[0075] Although SiO₂ film is used with the gestalt of this operation as an interlayer prepared in contact with a detached core 120, the insulator layer of others, such as Si₃N₄, can also be used. Although the thickness of SiO₂ film (interlayer) is suitably determined according to the formation purpose or extent of a function which can be demonstrated, it is desirable that it is 10nm – about 5 micrometers, and it is usually more desirable that it is 40nm – about 1 micrometer. What demonstrates at least one of the functions as the protective layer which an interlayer is formed for the various purpose, for example, protects the transferred layer 140 physically or chemically, an insulating layer, a conductive layer, the protection-from-light layer of laser light, the barrier layer for migration prevention, and a reflecting layer is mentioned.

[0076] In addition, the middle class, such as SiO₂ film, may not be formed depending on the case, but the direct transferred layer (thin film device layer) 140 may be formed on a detached core 120.

[0077] The transferred layer 140 (thin film device layer) is a layer containing thin film devices, such as TFT as shown in the right-hand side of drawing 2.

[0078] As a thin film device, besides TFT, for example, a thin-film diode, The optoelectric transducer (the photosensor, solar battery) and silicon resistance element which consist of PIN junction of silicon, Other thin film semiconductor devices, an electrode (example: a transparent electrode like ITO and the mesa film), Actuators, such as a switching element, memory, and a piezoelectric device, a micro mirror (piezo thin film ceramics), There are a micro MAG device which combined a magnetic-recording thin film head, a coil, an inductor, the charge of a thin film quantity magnetic-permiable material, and them, a filter, reflective film, a dichroic mirror, etc.

[0079] Such a thin film device is formed through usually comparatively high process temperature by relation with the formation approach. Therefore, as mentioned above in this case, as a substrate 100, the thing which has high dependability and which can bear that process temperature is needed.

[0080] As shown in [a process 3], next drawing 3, the thin film device layer 140 is joined to the imprint object 180 through a glue line 160 (adhesion).

[0081] As a suitable example of the adhesives which constitute a glue line 160, various hardening mold adhesives, such as photo-curing mold adhesives, such as reaction hardening mold adhesives, heat-curing mold adhesives, and ultraviolet curing mold adhesives, and aversion hardening mold adhesives, are mentioned. As a presentation of adhesives, what kind of thing is sufficient as an epoxy system, an acrylate system, a silicone system, etc., for example. Formation of such a glue line 160 is made for example, by the applying method.

[0082] After applying hardening mold adhesives on the transferred layer (thin film device layer) 140 and joining the imprint object 180 on it when using said hardening mold adhesives for example, said hardening mold adhesives are stiffened by the hardening approach according to the property of hardening mold adhesives, and the transferred layer (thin film device layer) 140 and the imprint object 180 are pasted up, and it fixes.

[0083] when adhesives are photo-curing molds, light is irradiated from the substrate of light transmission nature, and both the outsides of an imprint object or — from one outside of the

substrate 100 of light transmission nature, or the imprint object 180 of light transmission nature. As adhesives, photo-curing mold adhesives, such as an ultraviolet curing mold which cannot affect a thin film device layer easily, are desirable.

[0084] Water-soluble adhesives can also be used as a glue line 160. As this kind of water-soluble adhesives, it is KEMISHIRU made from for example, KEMITEKKU, Inc. Three Bond 3046 (trade name) by U-451D (trade name) and Three Bond Co., Ltd. etc. can be mentioned.

[0085] The adhesives which have melting nature to various kinds of organic solvents as a glue line 160 can also be used.

[0086] As a glue line 160, the adhesives which present an exfoliation operation with heating can also be used. As this kind of adhesives, RIBAARUFA made from for example, Japanese east DENKO (trade name) can be used.

[0087] As a glue line 160, the adhesives which present an exfoliation operation by UV irradiation can also be used. As this kind of adhesives, the dicing tape D-210 for glass ceramics by LINTEC Corp. and D-636 can be used.

[0088] In addition, unlike illustration, a glue line 160 may be formed in the imprint object 180 side, and the transferred layer (thin film device layer) 140 may be pasted up on it. In addition, when imprint object 180 the very thing has an adhesion function, for example, formation of a glue line 160 may be omitted.

[0089] although not limited especially as an imprint object 180 — a substrate (plate) — especially a transparency substrate is mentioned. In addition, such a substrate may be monotonous or may be a curve plate. Moreover, compared with said substrate 100, properties, such as thermal resistance and corrosion resistance, may be inferior in the imprint object 180. It is because the reason forms the transferred layer (thin film device layer) 140 in a substrate 100 side in this invention, and imprints the transferred layer (thin film device layer) 140 on the imprint object 180 after that, so it does not depend on the temperature conditions in the case of formation of the transferred layer (thin film device layer) 140 etc. for the property required of the imprint object 180, especially thermal resistance.

[0090] Therefore, when the maximum temperature in the case of formation of the transferred layer 140 is set to Tmax, a glass transition point (Tg) or softening temperature can use the following [Tmax] as a component of the imprint object 0. For example, a glass transition point (Tg) or softening temperature can constitute more preferably 800 degrees C or less of 500 degrees C or less of imprint objects 180 from an ingredient 320 degrees C or less still more preferably.

[0091] Moreover, although what has a certain amount of rigidity (reinforcement) as a mechanical property of the imprint object 180 is desirable, you may have flexibility and elasticity.

[0092] As a component of such an imprint object 180, various synthetic resin or various glass material are mentioned, and various synthetic resin and the usual cheap glass material (low melting point) are desirable especially.

[0093] As synthetic resin, any of thermoplastics and thermosetting resin are sufficient. For example, polyethylene, a polo propylene, an ethylene-pre pyrene copolymer, Polyolefines, such as an ethylene-vinylacetate copolymer (EVA), annular polyolefine, Denaturation polyolefine, a polyvinyl chloride, a polyvinylidene chloride, polystyrene, A polyamide, polyimide, polyamidoimide, a polycarbonate, Polly (4-methyl BENTEN -1), An ionomer, acrylic resin, polymethylmethacrylate, an acrylic-styrene copolymer (AS resin), Butadiene Styrene, a polio copolymer (EVOH), polyethylene terephthalate (PET), Polyester, such as polyp CHIREN terephthalate (PBT) and PURISHI clo hexane terephthalate (PCT), A polyether, a polyether ketone (PEK), a polyether ether ketone (PEEK), Polyether imide, polyacetal (POM), polyphenylene oxide, Denaturation polyphenylene oxide, polyarylate, aromatic polyester (liquid crystal polymer), Polytetrafluoroethylene, polyvinylidene fluoride, other fluorine system resin, A styrene system, a polyolefine system, a polyvinyl chloride system, a polyurethane system, Various thermoplastic elastomer, such as a fluororubber system and a chlorinated polyethylene system, EBOKISHI resin, phenol resin, a urea resin, melamine resin, unsaturated polyester, The copolymer which is mainly concerned with these, a blend object, a polymer alloy, etc. are mentioned, and silicone resin, polyurethane, etc. can be used combining 1 of sorts of these, and two sorts or more (as a

layered product for example, more than two-layer).

[0094] As glass material, silicic-acid glass (quartz glass), silicic-acid alkali glass, soda lime glass, potash lime glass, lead (alkali) glass, barium glass, borosilicate glass, etc. are mentioned, for example. Among these, compared with silicic-acid glass, the melting point is low, and shaping and processing are also comparatively easy the melting point, and, moreover, things other than silicic-acid glass have it, and are desirable. [cheap]

[0095] When using what consisted of synthetic resin as an imprint object 180, while being able to fabricate the large-scale imprint object 180 in one, even if it is complicated configurations, such as what has a curve side and irregularity, it can manufacture easily, and the various advantages that ingredient cost and a manufacturing cost are also cheap can be enjoyed. Therefore, use of synthetic resin is advantageous when manufacturing a large-sized and cheap device (for example, liquid crystal display).

[0096] In addition, the imprint object 180 may constitute some devices like what constitutes the device which became independent in itself like a liquid crystal cell, a color filter and an electrode layer, a dielectric layer, an insulating layer, and a semiconductor device.

[0097] Furthermore, the imprint objects 180 may be matter, such as a metal, ceramics, a stone, and wood paper, and may be on the front face of the structures, such as a wall, a column, head lining, and a windowpane, further on the field of the arbitration which constitutes a certain article (superiors of the front-face top of the field top of a clock, and an air-conditioner, and a printed circuit board).

[0098] As shown in [a process 4], next drawing 4, light is irradiated from the rear-face side of a substrate 100.

[0099] After this light penetrates a substrate 100, it is irradiated by the detached core 120. Thereby, the exfoliation in a layer and/or interfacial peeling arise in a detached core 120, and bonding strength is decreased or extinguished.

[0100] It is presumed that it is what is depended on phase changes, such as that ablation produces the principle which the exfoliation in a layer and/or interfacial peeling of a detached core 120 produce in the component of a detached core 120 and emission of the gas contained in the detached core 120, melting further produced immediately after an exposure, and evapotranspiration.

[0101] The fixed ingredient (component of a detached core 120) which absorbed exposure light is excited photochemistry-wise or thermally, ablation means association of the atom of the front face and interior or a molecule being cut, and emitting here, and it mainly appears as a phenomenon in which all or a part of component of a detached core 120 produces phase changes, such as melting and evapotranspiration (evaporation). Moreover, by said phase change, it may be in a minute firing condition and bonding strength may decline..

[0102] Conditions, such as a presentation of a detached core 120, and a class of light irradiated as one of the factor of the, wavelength, reinforcement, the attainment depth, are mentioned by in addition to this being influenced by various factors they are [whether a detached core 120 produces the exfoliation in a layer interfacial peeling is produced, or] the both.

[0103] Here, with the gestalt of this operation, after formation of a detached core 120, in order to make detached core 120 the very thing produce an exfoliation phenomenon more certainly at this 4th process, the ion for exfoliation promotion is poured in.

[0104] This ion for exfoliation promotion promotes three either of the followings, or the exfoliation phenomenon of the detached core [in / for an operation of two or more combination / nothing and the 4th process] 120 at least.

[0105] The ion for exfoliation promotion, for example, the hydrogen, (H) or nitrogen (N) with which one of them was poured into the detached core 120 by operation of this 4th process is gasified, and, thereby, exfoliation of a detached core 120 is promoted.

[0106] Other one was set like ion grouting for exfoliation promotion, it cut association of the atom or molecule which constitutes a detached core 120 with the ion for exfoliation promotion, for example, hydrogen, (H), nitrogen (N), or silicon (Si), and has given the damage beforehand to the detached core 120. Therefore, in the detached core 120 to which the damage was given beforehand, exfoliation arises comparatively easily by operation of the 4th process.

[0107] One of further others is set like ion grouting for exfoliation promotion, it changes the property of a detached core 120 with the ion for exfoliation promotion, for example, hydrogen, (H), nitrogen (N), or silicon (Si), and the adhesion of a detached core 120 and a substrate 100 has weakened it beforehand. Also in this case, in the detached core 120 which the adhesion with a substrate was able to weaken, exfoliation arises comparatively easily by operation of the 4th process.

[0108] As a light irradiated at the 4th process, if a detached core 120 is made to start the exfoliation in a layer, and/or interfacial peeling, what kind of thing may be used, for example, an X-ray, ultraviolet rays, the light, infrared radiation (heat ray), a laser beam, a millimeter wave, microwave, an electron ray, a radiation (alpha rays, beta rays, gamma ray), etc. will be mentioned. A laser beam is desirable at the point of being easy to produce exfoliation (ablation) of a detached core 120 also in it.

[0109] As laser equipment made to generate this laser beam, although various gas laser, solid state laser (semiconductor laser), etc. are mentioned, excimer laser, Nd-YAG laser, Ar laser, a CO₂ laser, a CO laser, helium-Ne laser, etc. are used suitably, and especially excimer laser is desirable also in it.

[0110] Since it outputs high energy in a short wavelength region, extremely, excimer laser can make a detached core 120 produce ablation for a short time, and it can exfoliate a detached core 120, without making the imprint object 180 and substrate 100 grade which therefore adjoin produce most temperature rises (i.e., without it producing degradation and damage).

[0111] Moreover, when it makes it faced that a detached core 120 produces ablation and there is a wavelength dependency of light, as for the wavelength of the laser beam irradiated, it is desirable that it is 100nm – about 350nm.

[0112] An example of permeability to the wavelength of light of a substrate 100 is shown in drawing 7. It has the property that permeability increases steeply to the wavelength of 200nm so that it may be illustrated. In such a case, light (wavelength of 308nm) with a wavelength of 210nm or more, for example, Xe-Cl excimer laser light, KrF laser light (wavelength of 248nm), etc. are irradiated.

[0113] Moreover, when making a detached core 120 cause phase changes, such as a gas evolution, evaporation, and sublimation, and giving a separation property to it, as for the wavelength of the laser beam irradiated, it is desirable that it is about 350 to 1200nm.

[0114] Moreover, as for especially the energy density in the case of excimer laser, it is desirable the energy density of the laser beam irradiated and to consider as about two 10 – 5000 mJ/cm, and it is more desirable to consider as about two 100 – 500 mJ/cm. Moreover, as for irradiation time, it is desirable to be referred to as about 1 – 1000ns, and it is more desirable to be referred to as about 10 – 100ns. When sufficient ablation etc. does not arise, and an energy density is high, when an energy density is low or irradiation time is short, or irradiation time is long, there is a possibility of having a bad influence on the transferred layer 140 by the exposure light which penetrated the detached core 120.

[0115] In addition, as a cure in case the exposure light which penetrated the detached core 120 reaches even the transferred layer 140 and does a bad influence, as shown in drawing 30, there is the approach of forming the metal membranes 124, such as a tantalum (Ta), on a detached core (laser absorption layer) 120, for example. Thereby, it is completely reflected by the interface of a metal membrane 124, and the laser light which penetrated the detached core 120 does not have a bad influence on the thin film device above it.

[0116] Next, the force is applied to a substrate 100 and this substrate 100 is made to secede from a detached core 120, as shown in drawing 5. Although not illustrated in drawing 5, a detached core may adhere on a substrate 100 after this balking.

[0117] Next, as shown in drawing 6, the extant detached core 120 is removed by the approach which combined approaches, such as washing, etching, ashing, and polish, or these. It means that the transferred layer (thin film device layer) 140 had been imprinted by the imprint object 180 by this.

[0118] In addition, when a part of detached core has adhered also to the substrate 100 from which it seceded, it removes similarly. In addition, when the substrate 100 consists of an

expensive ingredient like quartz glass, and a rare ingredient, reuse (recycle) is preferably presented with a substrate 100. That is, this invention can be applied to the substrate 100 to reuse, and usefulness is high.

[0119] The imprint to the imprint object 180 of the transferred layer (thin film device layer) 140 is completed through each above process. Then, conductive layers, such as removal of SiO₂ film which adjoins the transferred layer (thin film device layer) 140, and wiring of a up to [the transferred layer 140], formation of a desired protective coat, etc. can also be performed.

[0120] Thus, transferred layer (thin film device layer) 140 the very thing which is an exfoliated object is not exfoliated directly. Since it exfoliates in the detached core joined to the transferred layer (thin film device layer) 140, Irrespective of the property of an exfoliated object (transferred layer 140), conditions, etc., easily and certainly, it can exfoliate in homogeneity (imprint), there is also no damage to the exfoliated object (transferred layer 140) in accordance with exfoliation actuation, and the high dependability of the transferred layer 140 can be maintained.

[0121] Next, TFT of for example, CMOS structure is formed as a thin film device layer 140 on a substrate 100 and a detached core 120, and the example of the concrete manufacture process in the case of imprinting this on an imprint object is explained using drawing 8 – drawing 18. In addition, even if it attaches like ion grouting for exfoliation promotion carried out in the middle of this process, it explains.

[0122] (Process 1) as shown in drawing 8, on the translucency substrate (for example, quartz substrate) 100, laminating formation of a detached core (for example, LPCVD amorphous silicon layer formed of law) 120, an interlayer (for example, SiO₂ film) 142, and the amorphous silicon layer (for example, LPCVD — formed of law) 143 is carried out one by one, then laser light is irradiated from the upper part all over the amorphous silicon layer 143, and annealing is given. Thereby, the amorphous silicon layer 143 is recrystallized and turns into a polish recon layer. In addition, when carrying out laser annealing in this case with a beam scan, it is desirable in the same part that an optical exposure is carried out 2 times or more so that the beam cores of the beam of each time may lap unlike the beam scan to the above-mentioned detached core 120 (it removes in the case of a Gaussian beam). In this case, it is because there are no evils, such as optical leakage, and the amorphous silicon layer 143 can fully be recrystallized by carrying out a multiplex exposure.

[0123] If it is after formation of a detached core 120 and is before the laser annealing process for crystallization as an operation stage of the impregnation process of the ion for exfoliation promotion, it is desirable at the point that an ion implantation can be carried out without needing a mask.

[0124] Therefore, as the operation stage, it is after formation of the detached core 120 of (A) drawing 8, is after formation of an interlayer's 142 (B) interlayer 142 before formation, is after formation of the amorphous silicon layer 143 (before [C]) formation of the amorphous silicon layer 143, and becomes either in front of the laser annealing process for the crystallization. This (A) In – (C), the operation stage of (C) is the most desirable. In the reason, the formation process of the amorphous silicon layer 143, i.e., the formation process of a channel layer, serves as process temperature of about 425 degrees C in the present condition. When the hydrogen ion is already poured into the detached core 120 as in this case, for example, ion for exfoliation promotion, there is a possibility that hydrogen may escape from and come out of a detached core 120 at the temperature of 350 degrees C or more. Therefore, as for the impregnation process of the ion for exfoliation promotion, it is desirable to carry out with the operation stage after the channel stratification (C). However, since there is such no limit depending on the class of ion for exfoliation promotion, an operation stage (A) and (B) can also be carried out. Moreover, it is desirable on transistor characteristics that the damage resulting from impregnation of the ion for exfoliation promotion has not arisen in the layer after laser annealing of the amorphous silicon layer 143 was carried out and it was polycrystal-ized. In being (C), even if there is no generating of a damage itself in (A) and (B), and a damage arises in amorphous silicon layer 143 the very thing, the effect of the damage will be reduced according to a subsequent crystallization process.

[0125] In addition, like this ion grouting for exfoliation promotion, it can carry out using well-

known ion implantation equipment. That is, if a hydrogen ion is poured in, for example, the gas containing hydrogen is plasma-ized and the hydrogen ion generated by it can be poured into a detached core 120 by accelerating by electric field.

[0126] As an operation stage like ion grouting (D), you may be after laser annealing. In this case, transistor characteristics will not be degraded, if the mask of the part used as a channel field is carried out and it carries out an ion implantation. In addition, as for a mask, ion grouting is removed behind. As it is alike (process 2), then is shown in drawing 9, patterning of the polish recon layer obtained by laser annealing is carried out, and Islands 144a and 144b are formed as a channel pattern.

[0127] Like ion grouting for exfoliation promotion, it can carry out after the 2nd process (channel pattern formation process) as the operation stage (E) besides (A) – (D) mentioned above. In this case, as shown in drawing 31, it is on island 144a and 144b, and the mask pattern 201 is formed in the channel field in island 144a and 144b, and the part which counters. And the ion for exfoliation promotion, for example, a hydrogen ion, is turned and poured into a detached core 120 in the condition. Thereby, hydrogen does not contain to a channel field and transistor characteristics do not deteriorate. In addition, if it ends like ion grouting for exfoliation promotion, a mask pattern 201 will be removed.

[0128] (Process 3) As shown in drawing 10, wrap gate dielectric film 148a and 148b is formed for Islands 144a and 144b with a CVD method.

[0129] Like ion grouting for exfoliation promotion, it can carry out after the 3rd process (gate dielectric film) as the operation stage (F) besides (A) – (E) mentioned above. In this case, as shown in drawing 32, it is on gate-dielectric-film 148a and 148b, and it is desirable to form a mask pattern 202 in the channel field in island 144a and 144b and the part which counters.

[0130] (Process 4) As shown in drawing 11, the gate electrodes 150a and 150b which consist of polish recon or metal are formed.

[0131] (Process 5) As shown in drawing 12, the mask layer 170 which consists of polyimide etc. is formed, using gate electrode 150b and the mask layer 170 as a mask, it is a self aryne, for example, the ion implantation of boron (B) is performed. Of this, the p+ layers 172a and 172b are formed.

[0132] Like ion grouting for exfoliation promotion, this boron ion grouting simultaneously can be carried out as that operation stage (G) besides (A) – (F) mentioned above. In this case, the mixed gas of B-2H6(5%)+H2 (95%) is plasma-ized, the boron ion and hydrogen ion which were generated by that cause are accelerated, and it leads to a substrate, without minding a mass spectrograph. If it does so, even if it is the same acceleration voltage, while the boron ion with heavy mass stops at the polycrystalline silicon layer by the side of the upper layer, the hydrogen ion with light mass will be driven in more deeply, and it will reach to a detached core 120.

[0133] In addition, although gate electrode 150b functions as the mask pattern 201 of drawing 31, or the mask pattern 202 of drawing 32 similarly at this time, according to acceleration voltage, a mask layer can be further prepared on gate electrode 150b.

[0134] (Process 6) As shown in drawing 13, the mask layer 174 which consists of polyimide etc. is formed, using gate electrode 150a and the mask layer 174 as a mask, it is a self aryne, for example, the ion implantation of Lynn (P) is performed. Of this, the n+ layers 146a and 146b are formed.

[0135] Like ion grouting for exfoliation promotion, this phosphorus ion grouting simultaneously can be carried out as that operation stage (H) besides (A) – (G) mentioned above. Also in this case, the mixed gas of PH3(5%)+H2 (95%) is plasma-ized, the phosphorus ion and hydrogen ion which were generated by that cause are accelerated, and it leads to a substrate, without minding a mass spectrograph. If it does so, even if it is the same acceleration voltage, while the phosphorus ion with heavy mass stops at the polycrystalline silicon layer by the side of the upper layer, the hydrogen ion with light mass will be driven in more deeply, and it will reach to a detached core 120.

[0136] In addition, although gate electrode 150a functions as the mask pattern 201 of drawing 31, or the mask pattern 202 of drawing 32 similarly in this case, according to acceleration voltage, a mask layer can be further prepared on gate electrode 150a.

[0137] Moreover, although the operation stage like the above-mentioned ion grouting for exfoliation promotion (G) and (H) were as simultaneous as impurity ion grouting to the source in a process 5 and a process 6, and a drain field, they may be separately performed before and behind that.

[0138] (Process 7) As shown in drawing 14, an interlayer insulation film 154 is formed and Electrodes 152a-152d are alternatively formed after contact hole formation.

[0139] Thus, TFT of the formed CMOS structure corresponds to the transferred layer (thin film device layer) 140 in drawing 2 – drawing 6. In addition, a protective coat may be formed on an interlayer insulation film 154.

[0140] (Process 8) As shown in drawing 15, the epoxy resin layer 160 as a glue line is formed on TFT of a CMOS configuration, next TFT is stuck on the imprint object (for example, soda glass substrate) 180 through the epoxy resin layer 160. Then, heat is applied, an epoxy resin is stiffened and the imprint object 180 and TFT are pasted up (junction).

[0141] In addition, the photopolymer resin which is ultraviolet curing mold adhesives is sufficient as a glue line 160. In this case, ultraviolet rays are irradiated from the imprint object [not heat but] 180 side, and a polymer is stiffened.

[0142] (Process 9) As shown in drawing 16, Xe-Cl excimer laser light is irradiated from the rear face of the translucency substrate 100, for example. This produces and cheats out of exfoliation in the inside of the layer of a detached core 120, and/or an interface.

[0143] (Process 10) A substrate 100 is torn off as shown in drawing 17.

[0144] (Process 11) Finally etching removes a detached core 120. It means that TFT of a CMOS configuration had been imprinted by the imprint object 180 by this as shown in drawing 18.

[0145] <The gestalt of the 2nd operation>, next the gestalt of operation of the 2nd of this invention are explained with reference to drawing 33 – drawing 35. In addition, the gestalt of this 2nd operation imprints twice the transferred layer 140 which consists of thin film device layers, and, in addition to the process of drawing 1 of the gestalt of the 1st operation – drawing 6, the process of drawing 33 – drawing 35 is added.

[0146] Here, with the gestalt of this 2nd operation, the detached core 120 shown in drawing 2 – drawing 5 is called the 1st detached core. Moreover, with the gestalt of this 2nd operation, the glue line 160 of drawing 3 – drawing 6 is called the 2nd detached core. Furthermore, with the gestalt of this 2nd operation, the imprint object 180 of drawing 3 – drawing 6 is called a primary imprint object. Therefore, according to the gestalt of this 2nd operation, in the phase which the process of drawing 6 ended, it means that the transferred layer 140 had been imprinted by the primary imprint object 180 through the 2nd detached core 160.

[0147] With the gestalt of the 2nd operation here, the quality of the material of the 2nd detached core 160 can use the thing of the same quality of the material not only as thermofusion nature adhesives and water-soluble adhesives but the 1st detached core 120. In order to make easy exfoliation by this 2nd detached core 160 at this time, the ion implantation which was mentioned above and which was explained with the gestalt of the 1st operation can be performed.

[0148] More nearly hereafter, the additional processing of drawing 33 carried out after the process of drawing 6 – drawing 35 explains 1-3.

[0149] As [additional processing is shown in drawing 33 following the process of 1] drawing 6, the secondary imprint layer 200 is pasted up on the inferior surface of tongue (exposure) of the thin film device layer 140 through a glue line 190.

[0150] As a suitable example of the adhesives which constitute a glue line 190, various hardening mold adhesives, such as photo-curing mold adhesives, such as reaction hardening mold adhesives, heat-curing mold adhesives, and ultraviolet curing mold adhesives, and aversion hardening mold adhesives, are mentioned. As a presentation of adhesives, what kind of thing is sufficient as an epoxy system, an acrylate system, a silicone system, etc., for example. Formation of such a glue line 190 is made for example, by the applying method.

[0151] After applying hardening mold adhesives to the inferior surface of tongue of the transferred layer (thin film device layer) 140 and joining the secondary imprint object 200 further when using said hardening mold adhesives for example, said hardening mold adhesives are stiffened by the hardening approach according to the property of hardening mold adhesives, and

the transferred layer (thin film device layer) 140 and the secondary imprint object 200 are pasted up, and it fixes.

[0152] When adhesives are photo-curing molds, light is preferably irradiated from the outside of the secondary imprint object 200 of light transmission nature. As long as it uses as adhesives photo-curing mold adhesives, such as an ultraviolet curing mold which cannot affect a thin film device layer easily, an optical exposure may be carried out from the primary imprint object 180 side of light transmission nature, or primary [of light transmission nature] and the both sides of the secondary imprint object 180,200.

[0153] In addition, unlike illustration, a glue line 190 may be formed in the secondary imprint object 200 side, and the transferred layer (thin film device layer) 140 may be pasted up on it. In addition, when secondary imprint object 200 the very thing has an adhesion function, for example, formation of a glue line 190 may be omitted.

[0154] although not limited especially as a secondary imprint object 200 — a substrate (plate) — especially a transparency substrate is mentioned. In addition, such a substrate may be monotonous or may be a curve plate.

[0155] Moreover, compared with said substrate 100, properties, such as thermal resistance and corrosion resistance, may be inferior in the secondary imprint object 200. It is because the reason forms the transferred layer (thin film device layer) 140 in a substrate 100 side in this invention, and imprints the transferred layer (thin film device layer) 140 on the secondary imprint object 200 after that, so it does not depend on the temperature conditions in the case of formation of the transferred layer (thin film device layer) 140 etc. for the property required of the secondary imprint object 200, especially thermal resistance. This point is the same also about the primary imprint object 180.

[0156] Therefore, when the maximum temperature in the case of formation of the transferred layer 140 is set to Tmax, a glass transition point (Tg) or softening temperature can use the following [Tmax] as a component of primary and the secondary imprint object 180,200. For example, a glass transition point (Tg) or softening temperature can constitute more preferably primary and 800 degrees C or less of 500 degrees C or less of secondary imprint objects 180,200 from an ingredient 320 degrees C or less still more preferably.

[0157] Moreover, although what has a certain amount of ** (reinforcement) as a mechanical property of primary and the secondary imprint object 180,200 is desirable, you may have flexibility and elasticity.

[0158] As a component of such primary and the secondary imprint object 180,200, various synthetic resin or various glass material are mentioned, and various synthetic resin and the usual cheap glass material (low melting point) are desirable especially.

[0159] As synthetic resin, any of thermoplastics and thermosetting resin are sufficient. For example, polyethylene, a polo propylene, an ethylene-pre pyrene copolymer, Polyolefines, such as an ethylene-vinylacetate copolymer (EVA), annular polyolefine, Denaturation polyolefine, a polyvinyl chloride, a polyvinylidene chloride, polystyrene, A polyamide, polyimide, polyamidoimide, a polycarbonate, Polly (4-methyl BENTEN -1), An ionomer, acrylic resin, polymethylmethacrylate, an acrylic-styrene copolymer (AS resin), Butadiene Styrene, a polio copolymer (EVOH), polyethylene terephthalate (PET), Polyester, such as polyp CHIREN terephthalate (PBT) and PURISHI clo hexane terephthalate (PCT), A polyether, a polyether ketone (PEK), a polyether ether ketone (PEEK), Polyether imide, polyacetal (POM), polyphenylene oxide, Denaturation polyphenylene oxide, polyarylate, aromatic polyester (liquid crystal polymer), Polytetrafluoroethylene, polyvinylidene fluoride, other fluorine system resin, A styrene system, a polyolefine system, a polyvinyl chloride system, a polyurethane system, Various thermoplastic elastomer, such as a fluororubber system and a chlorinated polyethylene system, EBOKISHI resin, phenol resin, a urea resin, melamine resin, unsaturated polyester, The copolymer which is mainly concerned with these, a blend object, a polymer alloy, etc. are mentioned, and silicone resin, polyurethane, etc. can be used combining 1 of sorts of these, and two sorts or more (as a layered product for example, more than two-layer).

[0160] As glass material, silicic-acid glass (quartz glass), silicic-acid alkali glass, soda lime glass, potash lime glass, lead (alkali) glass, barium glass, borosilicate glass, etc. are mentioned, for

example. Among these, compared with silicic-acid glass, the melting point is low, and shaping and processing are also comparatively easy the melting point, and, moreover, things other than silicic-acid glass have it, and are desirable. [cheap]

[0161] When using what consisted of synthetic resin as a secondary imprint object 200, while being able to fabricate the large-scale secondary imprint object 200 in one, even if it is complicated configurations, such as what has a curve side and irregularity, it can manufacture easily, and the various advantages that ingredient cost and a manufacturing cost are also cheap can be enjoyed. Therefore, use of synthetic resin is advantageous when manufacturing a large-sized and cheap device (for example, liquid crystal display).

[0162] In addition, the secondary imprint object 200 may constitute some devices like what constitutes the device which became independent in itself like a liquid crystal cell, a color filter and an electrode layer, a dielectric layer, an insulating layer, and a semiconductor device.

[0163] Furthermore, primary and the secondary imprint objects 180,200 may be matter, such as a metal, ceramics, a stone, and wood paper, and may be on the front face of the structures, such as a wall, a column, head lining, and a windowpane, further on the field of the arbitration which constitutes a certain article (superiors of the front-face top of the field top of a clock, and an air-conditioner, and a printed circuit board).

[0164] As [additional processing is shown in 2], next drawing 34, thermofusion of the thermofusion nature glue line 160 which is the 2nd detached core is heated and carried out. Consequently, since the adhesive strength of the thermofusion nature glue line 160 becomes weaker, it can be made to secede from the primary imprint object 180 by the thin film device layer 140. In addition, this primary imprint object 180 can be repeated and reused by removing the thermofusion nature adhesives adhering to the primary imprint object 180.

[0165] What is necessary is just to dip preferably the field which contains the 2nd detached core 160 at least in pure water that what is necessary is just to make water contact, when the water-soluble adhesives mentioned above as the 2nd detached core 160 are used. What is necessary is just to contact the field which contains the 2nd detached core 160 at least to an organic solvent, when the organic solvent melting nature adhesives mentioned above as the 2nd detached core 160 are used. the field which contains the 2nd detached core 160 at least when the adhesives which present an exfoliation operation by heating or UV irradiation mentioned above as the 2nd detached core 160 are used — other layers — minding — heating — or what is necessary is just to carry out UV irradiation Moreover, when an ablation layer is used like the 1st detached core 120 as the 2nd detached core, the 2nd detached core 160 is made to produce an exfoliation phenomenon by optical exposure. That exfoliation is promoted by the effectiveness of impregnation ion at this time.

[0166] As [additional processing is shown in drawing 35 by removing the 2nd detached core 160 which adhered to the front face of the thin film device layer 140 at the 3] last, the thin film device layer 140 imprinted by the secondary imprint object 200 can be obtained. Here, the laminating relation of the thin film device layer 140 to this secondary imprint object 200 becomes the same as the laminating relation of the thin film device layer 140 to the original substrate 100, as shown in drawing 2.

[0167] The imprint to the secondary imprint object 200 of the transferred layer (thin film device layer) 140 is completed through each above process. Then, conductive layers, such as removal of SiO₂ film which adjoins the transferred layer (thin film device layer) 140, and wiring of a up to [the transferred layer 140], formation of a desired protective coat, etc. can also be performed.

[0168] With the gestalt of the 2nd operation, transferred layer (thin film device layer) 140 the very thing which is an exfoliated object is not exfoliated directly. In order to dissociate in the 1st detached core 120 and the 2nd detached core 160 and to imprint on the secondary imprint object 200, Irrespective of the property of a dissociated object (transferred layer 140), conditions, etc., easily and certainly, it can imprint to homogeneity, there is also no damage to the dissociated object (transferred layer 140) in accordance with separation actuation, and the high dependability of the transferred layer 140 can be maintained.

[0169] If the technique explained with the <gestalt of the 3rd operation> above-mentioned 1st and the gestalt of the 2nd operation is used, the microcomputer constituted using the thin film

device as shown in drawing 19 (a), for example can be formed on a desired substrate.

[0170] In drawing 19 (a), the solar battery 340 possessing the PIN junction of an amorphous silicon for supplying the supply voltage of CPU300, RAM320 and the I/O circuits 360 where the thin film device was used and the circuit was constituted, and these circuits is carried on the flexible substrate 182 which consists of plastics etc.

[0171] Since the microcomputer of drawing 19 (a) is formed on the flexible substrate, as shown in drawing 19 (b), since it is lightweight, it has strongly the description that it is strong also to fall in bending.

[0172] The gestalt of <gestalt of the 4th operation> book operation explains the example of the manufacture process in the case of creating the liquid crystal display of the active-matrix mold using a active-matrix substrate as shown in drawing 20 and drawing 21 using the imprint technique of an above-mentioned thin film device.

[0173] (Configuration of a liquid crystal display) As shown in drawing 20, the liquid crystal display of a active-matrix mold possesses the sources 400 of the illumination light, such as a back light, a polarizing plate 420, the active-matrix substrate 440, liquid crystal 460, the opposite substrate 480, and a polarizing plate 500.

[0174] In addition, if it constitutes as a reflective mold liquid crystal panel which replaced with the source 400 of the illumination light, and adopted the reflecting plate when using a flexible substrate like plastic film for the active-matrix substrate 440 and the opposite substrate 480 of this invention, there is flexibility and a lightweight active matrix liquid crystal panel strong against an impact and can be realized. In addition, when a pixel electrode is formed with a metal, a reflecting plate and a polarizing plate 420 become unnecessary.

[0175] The active-matrix substrate 440 used with the gestalt of this operation arranges TFT in the pixel section 442, and is a driver built-in active-matrix substrate in which the driver circuit (a scanning-line driver and data-line driver) 444 was carried further.

[0176] The sectional view of the important section of this active matrix liquid crystal display is shown in drawing 21, and the circuitry of the important section of a liquid crystal display is shown in drawing 22.

[0177] As shown in drawing 22, the gate is connected to the gate line G1, one side of a source drain is connected to the data line D1, and the pixel section 442 contains TFT (M1) by which another side of a source drain was connected to liquid crystal 460, and liquid crystal 460.

[0178] Moreover, the driver section 444 is constituted including TFT (M2) formed of the same process as TFT (M1) of the pixel section.

[0179] As shown in the left-hand side of drawing 21, TFT (M1) in the pixel section 442 is constituted including the source drain layers 1100a and 1100b, channel 1100e, gate-dielectric-film 1200a, gate electrode 1300a, an insulator layer 1500, and the source drain electrodes 1400a and 1400b.

[0180] In addition, a reference number 1700 is a pixel electrode and a reference number 1702 shows the field (electrical-potential-difference impression field to liquid crystal) where the pixel electrode 1700 impresses an electrical potential difference to liquid crystal 460. The orientation film is omitted among drawing. The pixel electrode 1700 is constituted by metals (in the case of the liquid crystal panel of a reflective mold), such as ITO (in the case of the liquid crystal panel of a light transmission mold), or aluminum. Moreover, in drawing 21, in the electrical-potential-difference impression field 1702 to liquid crystal, although the substrate insulator layer 1000 under the pixel electrode 1700 (interlayer) is removed completely, it is not necessarily limited to this, and since the substrate insulator layer (interlayer) 1000 is thin, when not becoming the hindrance of the electrical-potential-difference impression to liquid crystal, you may leave.

[0181] Moreover, as shown in the right-hand side of drawing 21, TFT (M2) which constitutes the driver section 444 is constituted including the source, the drain layers 1100c and 1100d, channel 1100f, gate-dielectric-film 1200b, gate electrode 1300b, an insulator layer 1500, and the source drain electrodes 1400c and 1400d.

[0182] In addition, in drawing 21, a reference number 480 is for example, an opposite substrate (for example, soda glass substrate), and a reference number 482 is a common electrode. Moreover, a reference number 1000 is SiO₂ film, a reference number 1600 is an interlayer

insulation film (for example, SiO₂ film), and a reference number 1800 is a glue line. Moreover, a reference number 1900 is a substrate (imprint object) which consists for example, of a soda glass substrate.

[0183] (Manufacture process of a liquid crystal display) The manufacture process of the liquid crystal display of drawing 21 is hereafter explained with reference to drawing 23 – drawing 27.

[0184] First, it forms through the same manufacture process as drawing 8 – drawing 18 on the substrate (for example, quartz substrate) 3000 which it is reliable in TFT (M1, M2) like drawing 23, and penetrates laser light, and a protective coat 1600 is constituted. In addition, in drawing 23, a reference number 3100 is a detached core (laser absorption layer) into which the ion for exfoliation promotion is poured. Moreover, in drawing 23, both TFT(s) (M1, M2) are taken as MOSFET of n mold. However, it is good also as not the thing limited to this but MOSFET of p mold, and CMOS structure.

[0185] Next, as shown in drawing 24, a protective coat 1600 and the substrate insulator layer 1000 are etched alternatively, and openings 4000 and 4200 are formed alternatively. These two openings are formed in coincidence using a common etching process. In addition, although the substrate insulator layer (interlayer) 1000 is completely removed in opening 4200 in drawing 24, it is not necessarily limited to this, and since the substrate insulator layer (interlayer) 1000 is thin, when not becoming the hindrance of the electrical-potential-difference impression to liquid crystal, you may leave.

[0186] Next, as shown in drawing 25, the pixel electrode 1700 which consists of metals, such as ITO film or aluminum, is formed. In using the ITO film, it becomes the liquid crystal panel of a transparency mold, and in using metals, such as aluminum, it becomes the liquid crystal panel of a reflective mold. Next, as shown in drawing 26, a substrate 1900 is joined through a glue line 1800 (adhesion).

[0187] Next, excimer laser light is irradiated from the rear face of a substrate 3000, the operation by the ion for exfoliation promotion is also used, and a detached core 120 is made to produce an exfoliation phenomenon, as shown in drawing 26. Then, a substrate 3000 is torn off. Since the force like ** is not required for tearing off at this time, a mechanical damage does not arise in TFT.

[0188] Next, a detached core (laser absorption layer) 3100 is removed. Thereby, the active-matrix substrate 440 as shown in drawing 27 is completed. It has exposed and the electric connection with liquid crystal is possible for the base (field of a reference number 1702) of the pixel electrode 1700. Then, the orientation film is formed in the front face of the insulator layer (interlayers, such as SiO₂) 1000 of the active-matrix substrate 440, and pixel electrode 1702 front face, and orientation processing is performed. The orientation film is omitted in drawing 27.

[0189] And the pixel electrode 1709 and the common electrode which counters are further formed in the front face, the opposite substrate 480 and the active MATORIKU substrate 440 of drawing 21 with which orientation processing of the front face was carried out are closed with a sealing agent (sealant), liquid crystal is enclosed among both substrates, and a liquid crystal display as shown in drawing 21 is completed.

[0190] The gestalt of operation of the 5th of this invention is shown in <gestalt of the 5th operation> drawing 28.

[0191] With the gestalt of this operation, multiple-times activation of the imprint approach of an above-mentioned thin film device is carried out, on a larger substrate (imprint object) than the substrate of an imprinting agency, two or more patterns containing a thin film device are imprinted, and, finally a large-scale active-matrix substrate is formed.

[0192] That is, on the big substrate 7000, the imprint of multiple times is performed and the pixel sections 7100a–7100P are formed. TFT and wiring are formed in the pixel section as surrounded and shown to the drawing 28 bottom by the alternate long and short dash line. In drawing 28, a reference number 7210 is the scanning line, a reference number 7200 is a signal line and a reference number 7230 is [a reference number 7220 is a gate electrode and] a pixel electrode.

[0193] The large-scale active-matrix substrate carrying a reliable thin film device can be created by repeating and using a reliable substrate or carrying out multiple-times activation of the

imprint of a thin film pattern using two or more 1st substrates.

[0194] The gestalt of operation of the 6th of <gestalt of the 6th operation> this invention is shown in drawing 29 .

[0195] The description of the gestalt of this operation is imprinting two or more patterns containing the thin film device (that is, thin film device with which minimum line width's differs) with which multiple-times activation of the imprint approach of an above-mentioned thin film device is carried out, and the design Ruhr's (that is, design rule's when carrying out a pattern design's) differs on a bigger substrate than the substrate top of an imprinting agency.

[0196] In drawing 29 , the driver circuit (8000–8032) created in the more detailed manufacture process rather than the pixel section (7100a–7100p) is created around the substrate 6000 by the imprint of multiple times in the active-matrix substrate of driver loading.

[0197] Since the shift register which constitutes a driver circuit carries out actuation of a logic level to the bottom of a low battery, rather than Pixel TFT, pressure-proofing may be low, and as it is therefore set to TFT more detailed than Pixel TFT, high integration can be attained.

[0198] According to the gestalt of this operation, two or more circuits where design Ruhr level differs (that is, manufacture processes differ) are realizable on one substrate. In addition, since high pressure-proofing is the need like Pixel TFT, a sampling means (thin film transistor M2 of drawing 22) to sample a data signal by control of a shift register may be formed in the same process as Pixel TFT / same design Ruhr.

[Translation done.]

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EXAMPLE

[Example] Next, the concrete example of this invention is explained.

[0200] (Example 1) The quartz substrate (1630 degrees C, a strain point: softening temperature : 1070 degrees C, permeability of excimer laser : about 100%) with a 50mm[50mm by] x thickness of 1.1mm was prepared, and the amorphous silicon (a-Si) film was formed in one side of this quartz substrate as a detached core (laser beam absorption layer) with the low voltage CVD method (Si₂H₆ gas, 425 degrees C). The thickness of a detached core was 100nm.

[0201] Next, it is SiO₂ as an interlayer on a detached core. The film was formed with the ECR-CVD method (SiH₄+O₂ gas, 100 degrees C). An interlayer's thickness was 200nm.

[0202] Next, the amorphous silicon film of 50nm of thickness was formed as a transferred layer on the interlayer with the low voltage CVD method (Si₂H₆ gas, 425 degrees C), a laser beam (wavelength of 308nm) is irradiated, this amorphous silicon film was crystallized, and it considered as the polish recon film. Then, to this polish recon film, predetermined pattern NINGU was given and the field used as the source drain channel of a thin film transistor was formed. then, a TEOS-CVD method (SiH₄+O₂ gas) — 1200nm gate dielectric film SiO₂ after forming, form a gate electrode (structure where laminating formation of the refractory metals, such as Mo, was carried out at polish recon), on gate dielectric film, and it carries out an ion implantation, using a gate electrode as a mask — self align —like (selfer line) — the source drain field was formed and the thin film transistor was formed. At this time, the hydrogen ion was poured into coincidence at the detached core. Then, the electrode connected to a source drain field and wiring, and wiring which leads to a gate electrode are formed if needed. Although aluminum is used for these electrodes and wiring, it is not limited to this. Moreover, when worrying about melting of aluminum by the laser radiation of a back process, a high-melting metal (what is not fused by the laser radiation of a back process) may be used rather than aluminum.

[0203] Next, ultraviolet curing mold adhesives were applied on said thin film transistor (thickness: 100 micrometers), further, after joining a transparent large-sized glass substrate (soda glass, softening-temperature:740 degree C, a strain point: 511 degrees C) with a 300mm[200mm by] x thickness of 1.1mm to the paint film as an imprint object, ultraviolet rays were irradiated from the glass substrate side, adhesives were stiffened, and adhesion immobilization of these was carried out.

[0204] Next, Xe-Cl excimer laser (wavelength: 308nm) was irradiated from the quartz substrate side, and the detached core was made to produce exfoliation (exfoliation in a layer, and interfacial peeling) by carrying out the beam scan shown after drawing 31. The irradiated energy density of Xe-Cl excimer laser was 250 mJ/cm², and irradiation time was 20ns. In addition, the exposure of excimer laser had a spot beam exposure and the Rhine beam exposure, and when it was a spot beam exposure, the spot exposure was carried out to the predetermined unit field (for example, 8mmx8mm), and it irradiated this spot exposure, carrying out a beam scan so that the exposure field of each time may not lap (it does not lap all around like). Moreover, in the Rhine beam exposure, it irradiated, carrying out the beam scan of the predetermined unit field (for example, 378mmx0.1mm and 378mmx0.3mm (field where, as for these, 90% or more of energy is obtained)) similarly, so that the exposure field of each time may not lap.

[0205] Then, the quartz substrate and the glass substrate (imprint object) were torn off in the

detached core, and the thin film transistor and interlayer who were formed on the quartz substrate were imprinted to the glass substrate side.

[0206] Then, etching, washing, or those combination removed the detached core adhering to the front face of the middle class by the side of a glass substrate. Moreover, processing with the same said of a quartz substrate was performed, and the reuse was presented.

[0207] In addition, if the glass substrate used as an imprint object is a bigger substrate than a quartz substrate, the imprint to a glass substrate from a quartz substrate like this example can be repeatedly carried out to a superficially different field, and many thin film transistors can be formed on a glass substrate from the number of the thin film transistors which can be formed in a quartz substrate. Furthermore, on a glass substrate, a laminating can be carried out repeatedly and more thin film transistors can be formed similarly.

[0208] (Example 2) a detached core — a detached core formation process — H (hydrogen) — 20at(s)% — the thin film transistor was imprinted like the example 1 except having considered as the amorphous silicon film to contain.

[0209] In addition, adjustment of the amount of H in the amorphous silicon film was performed by setting up suitably the conditions at the time of membrane formation by the low voltage CVD method.

[0210] (Example 3) The thin film transistor was imprinted like the example 1 except having used the detached core as the ceramic thin film (presentation— $b\text{TiO}_3$, thickness: 200nm) formed with the sol-gel method with the spin coat.

[0211] (Example 4) The thin film transistor was imprinted like the example 1 except having used the detached core as the ceramic thin film (presentation: BaTiO_3 , thickness: 400nm) formed by sputtering.

[0212] (Example 5) The thin film transistor was imprinted like the example 1 except having used the detached core as the ceramic thin film (presentation :P b (Zr TiO_3) PZT) and thickness: 50nm) formed by the laser-ablation method.

[0213] (Example 6) The thin film transistor was imprinted like the example 1 except having used the detached core as the polyimide film (thickness: 200nm) formed with the spin coat.

[0214] (Example 7) The thin film transistor was imprinted like the example 1 except having used the detached core as the polyphenylene sulfide film (thickness: 200nm) formed with the spin coat.

[0215] (Example 8) The thin film transistor was imprinted like the example 1 except having used the detached core as aluminum layer (thickness: 300nm) formed by sputtering.

[0216] (Example 9) As an exposure light, the thin film transistor was imprinted like the example 2 except having used Kr-F excimer laser (wavelength: 248nm). In addition, the energy density of the irradiated laser was 250 mJ/cm², and irradiation time was 20ns.

[0217] (Example 10) As an exposure light, the thin film transistor was imprinted like the example 2 except having used Nd-YAIG laser (wavelength: 1068nm). In addition, the energy density of the irradiated laser was 400 mJ/cm², and irradiation time was 20ns.

[0218] (Example 11) The thin film transistor was imprinted like the example 1 except having considered as the thin film transistor of the polish recon film (80nm of thickness) by elevated-temperature process 1000 degree C as a transferred layer.

[0219] (Example 12) As an imprint object, the thin film transistor was imprinted like the example 1 except having used the transparency substrate made from a polycarbonate (glass transition point: 130 degrees C).

[0220] (Example 13) As an imprint object, the thin film transistor was imprinted like the example 2 except having used the transparency substrate made of an AS resin (glass transition point: 70-90 degrees C).

[0221] (Example 14) As an imprint object, the thin film transistor was imprinted like the example 3 except having used the transparency substrate made from polymethylmethacrylate (glass transition point: 70-90 degrees C).

[0222] (Example 15) As an imprint object, the thin film transistor was imprinted like the example 5 except having used the transparency substrate made from polyethylene terephthalate (glass transition point: 67 degrees C).

[0223] (Example 16) As an imprint object, the thin film transistor was imprinted like the example 6 except having used the transparency substrate made from high density polyethylene (glass transition point: 77–90 degrees C).

(Example 17) As an imprint object, the thin film transistor was imprinted like the example 9 except having used the transparency substrate made from a polyamide (glass transition point: 145 degrees C).

[0224] (Example 18) As an imprint object, the thin film transistor was imprinted like the example 10 except having used the transparency substrate made of an epoxy resin (glass transition point: 120 degrees C).

[0225] (Example 19) As an imprint object, the thin film transistor was imprinted like the example 11 except having used the transparency substrate made from polymethylmethacrylate (glass transition point: 70–90 degrees C).

[0226] About examples 1–19, when the condition of the imprinted thin film transistor was guessed the ** view under the naked eye and the microscope, respectively, all had neither a defect nor nonuniformity and the imprint was made by homogeneity.

[0227] As stated above, when using the imprint technique of this invention, it was able to become possible to imprint a thin film device (transferred layer) to various imprint objects, especially exfoliation of a substrate required for an imprint was able to be performed reasonable, without acting too much force. or [that a thin film cannot be formed directly by this] — or it can be formed by imprint also to what consisted of an ingredient unsuitable for forming, an ingredient with easy shaping, a cheap ingredient, etc., the large-sized body which is hard to move.

[0228] That in which properties, such as thermal resistance and corrosion resistance, are inferior compared with various synthetic resin or a substrate ingredient like glass material with the low melting point can be used especially for an imprint object, therefore — for example, it can face manufacturing the liquid crystal display in which the thin film transistor (especially poly-Si TFT) was formed on the transparency substrate, and a large-sized and cheap liquid crystal display can be easily manufactured now as an imprint object as a substrate using the quartz-glass substrate which is excellent in thermal resistance by using a transparency substrate of the ingredient which it is cheap and processing tends to carry out like glass material with low various synthetic resin and melting point. Such an advantage is the same also about manufacture of not only a liquid crystal display but other devices.

[0229] Moreover, although the above advantages are enjoyed, since a transferred layer like a functional thin film can be formed to a heat-resistant high substrate like a reliable substrate, especially a quartz-glass substrate and patterning can be carried out further, a reliable functional thin film can be formed on an imprint object irrespective of the material property of an imprint object.

[0230] Moreover, although such a reliable substrate is expensive, it is also possible to reuse it and, therefore, a manufacturing cost is also reduced.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the sectional view showing the 1st process in the gestalt of implementation of the 1st of the imprint approach of the thin film device of this invention.

[Drawing 2] It is the sectional view showing the 2nd process in the gestalt of implementation of the 1st of the imprint approach of the thin film device of this invention.

[Drawing 3] It is the sectional view showing the 3rd process in the gestalt of implementation of the 1st of the imprint approach of the thin film device of this invention.

[Drawing 4] It is the sectional view showing the 4th process in the gestalt of implementation of the 1st of the imprint approach of the thin film device of this invention.

[Drawing 5] It is the sectional view showing the 5th process in the gestalt of implementation of the 1st of the imprint approach of the thin film device of this invention.

[Drawing 6] It is the sectional view showing the 6th process in the gestalt of implementation of the 1st of the imprint approach of the thin film device of this invention.

[Drawing 7] It is drawing showing change of the permeability to the wavelength of the laser light of the 1st substrate (substrate 100 of drawing 1).

[Drawing 8] It is the sectional view showing the 1st process for forming the thin film device of drawing 2 .

[Drawing 9] It is the sectional view showing the 2nd process for forming the thin film device of drawing 2 .

[Drawing 10] It is the sectional view showing the 3rd process for forming the thin film device of drawing 2 .

[Drawing 11] It is the sectional view showing the 4th process for forming the thin film device of drawing 2 .

[Drawing 12] It is the sectional view showing the 5th process for forming the thin film device of drawing 2 .

[Drawing 13] It is the sectional view showing the 6th process for forming the thin film device of drawing 2 .

[Drawing 14] It is the sectional view showing the 7th process for forming the thin film device of drawing 2 .

[Drawing 15] It is a sectional view to show the process shown in drawing 3 in a detail.

[Drawing 16] It is a sectional view to show the detail of the process shown in drawing 4 .

[Drawing 17] It is a sectional view to show the detail of the process shown in drawing 5 .

[Drawing 18] It is a sectional view to show the detail of the process shown in drawing 6 .

[Drawing 19] (a) and (b) are both the perspective views of the microcomputer manufactured using this invention.

[Drawing 20] It is drawing for explaining the configuration of a liquid crystal display.

[Drawing 21] It is drawing showing the cross-section structure of the important section of a liquid crystal display.

[Drawing 22] It is drawing for explaining the configuration of the important section of a liquid crystal display.

[Drawing 23] It is the sectional view of the device in which the 1st process of the manufacture

approach of the active-matrix substrate using this invention is shown.

[Drawing 24] It is the sectional view of the device in which the 2nd process of the manufacture approach of the active-matrix substrate using this invention is shown.

[Drawing 25] It is the sectional view of the device in which the 3rd process of the manufacture approach of the active-matrix substrate using this invention is shown.

[Drawing 26] It is the sectional view of the device in which the 4th process of the manufacture approach of the active-matrix substrate using this invention is shown.

[Drawing 27] It is the sectional view of the device in which the 5th process of the manufacture approach of the active-matrix substrate using this invention is shown.

[Drawing 28] It is drawing of a ***** sake about other examples of the imprint approach of the thin film device of this invention.

[Drawing 29] It is drawing of a ***** sake about the example of further others of the imprint approach of the thin film device of this invention.

[Drawing 30] It is drawing of a ***** sake about the modification of the imprint approach of the thin film device of this invention.

[Drawing 31] It is the sectional view showing the impregnation process of the ion for exfoliation promotion carried out after the process of drawing 9.

[Drawing 32] It is the sectional view showing the impregnation process of the ion for exfoliation promotion carried out after the process of drawing 10.

[Drawing 33] The additional processing at the time of the 2 times imprint performed by continuing at the process of drawing 6 is the outline sectional view showing 1.

[Drawing 34] The additional processing at the time of the 2 times imprint performed by continuing at the process of drawing 33 is the outline sectional view showing 2.

[Drawing 35] The additional processing at the time of the 2 times imprint performed by continuing at the process of drawing 34 is the outline sectional view showing 3.

[Description of Notations]

100 Substrate

120 Detached Core

140 Thin Film Device Layer

160 Glue Line

180 Imprint Object

[Translation done.]

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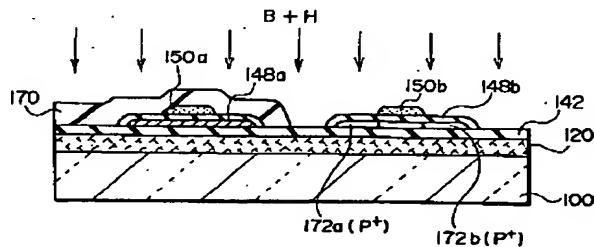
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(54)【発明の名称】 薄膜デバイスの剥離方法、薄膜デバイスの転写方法、薄膜デバイス、アクティブマトリクス基板
および液晶表示装置

(57)【要約】

【課題】 基板上に形成された薄膜デバイスを、その基板から容易に剥離させることのできる方法を提供すること。

【解決手段】 基板(100)上に分離層(120)を設けておき、その基板上にTFT等の薄膜デバイス(140)を形成する。その薄膜デバイス(140)の形成プロセス中に、剥離促進用イオン例えは水素イオンを、分離層(120)に注入する。薄膜デバイス(140)の形成後、好ましくは接着層(160)を介して薄膜デバイス(140)を転写体(180)に接合した後に、基板側からレーザー光を照射する。これによって分離層(120)では、剥離促進用イオンの作用をも利⽤して剥離を生じせしめる。その薄膜デバイス(140)を基板(100)より離脱させる。これにより、どのような基板にでも所望の薄膜デバイスを転写できる。



【特許請求の範囲】

【請求項1】 基板上に分離層を形成する第1工程と、前記分離層上に薄膜デバイスを形成する第2工程と、前記分離層の層内および／または界面において剥離現象を生じさせて、前記基板を前記分離層から剥離させる第3工程と、
を有する薄膜デバイスの剥離方法であって、
前記第3工程の前に、前記分離層にイオンを注入するイオン注入工程を設けたことを特徴とする薄膜デバイスの剥離方法。

【請求項2】 請求項1において、

前記3工程では、前記分離層に注入された前記イオンを気体化させる工程を含むことを特徴とする薄膜デバイスの剥離方法。

【請求項3】 請求項2において、

前記第3工程は、記分離層に光照射する工程を含むことを特徴とする薄膜デバイスの剥離方法。

【請求項4】 請求項1乃至3のいずれかにおいて、前記イオン注入工程では、前記イオンにより前記分離層を構成する原子または分子の結合を切断して、前記分離層に予めダメージを与えておくことを特徴とする薄膜デバイスの剥離方法。

【請求項5】 請求項1乃至4のいずれかにおいて、前記イオン注入工程では、前記イオンにより前記分離層の特性を変化させて、前記分離層と前記基板との密着性を予め弱めておくことを特徴とする薄膜デバイスの剥離方法。

【請求項6】 請求項1乃至5のいずれかにおいて、前記第2工程は、薄膜トランジスタを形成するための薄膜トランジスタ形成工程を有し、

前記薄膜トランジスタ形成工程はチャネル層形成工程を含み、

前記イオン注入工程は、前記チャネル層形成工程の後に実施されることを特徴とする薄膜デバイスの剥離方法。

【請求項7】 請求項6において、

前記薄膜トランジスタ形成工程は、前記チャネル層形成工程後にチャネルパターン形成工程を含み、

前記イオン注入工程は、前記チャネルパターン形成工程の後に実施されることを特徴とする薄膜デバイスの剥離方法。

【請求項8】 請求項6または7において、

前記イオン注入工程は、前記チャネル層のうちチャネル領域となる領域上にマスクを形成して実施されることを特徴とする薄膜デバイスの剥離方法。

【請求項9】 請求項7において、

前記薄膜トランジスタ形成工程は、前記チャネルパターン形成工程後に、該チャネルパターン上にゲート絶縁膜を形成する工程と、該ゲート絶縁膜上であって前記チャネル領域と対向する領域にゲート電極を形成する工程と、を含み、

前記ゲート電極をマスクとして前記イオン注入工程を実施することを特徴とする薄膜デバイスの剥離方法。

【請求項10】 請求項8または9において、前記イオン注入工程は、前記チャネルパターン内のソース領域及びドレイン領域の少なくとも一方に打ち込まれる不純物イオンと、それよりも質量が軽く前記分離層に打ち込まれる前記イオンとを、同時に注入することを特徴とする薄膜デバイスの剥離方法。

【請求項11】 請求項6において、

10 前記薄膜トランジスタ形成工程は、前記チャネル層としてアモルファスシリコン層を形成する工程と、その後前記アモルファスシリコン層をレーザアニールして結晶化させる結晶化工程と、を含み、

前記イオン注入工程は、前記結晶化工程の前に実施されることを特徴とする薄膜デバイスの剥離方法。

【請求項12】 請求項1乃至11のいずれかにおいて、前記イオンは水素イオンであることを特徴とする薄膜デバイスの剥離方法。

20 【請求項13】 請求項12において、

前記イオン注入工程後に実施される工程のプロセス温度を、350℃未満としたことを特徴とする薄膜デバイスの剥離方法。

【請求項14】 請求項1乃至13のいずれかに載の剥離方法を用いて前記基板より剥離されて成る薄膜デバイス。

【請求項15】 マトリクス状に配置された薄膜トランジスタと、その薄膜トランジスタの一端に接続された画素電極とを含んで画素部が構成されるアクティブマトリクス基板であって、

30 請求項6乃至13のいずれかに記載の方法を用いて前記画素部の薄膜トランジスタを転写することにより製造されたアクティブマトリクス基板。

【請求項16】 請求項15に記載のアクティブマトリクス基板を用いて製造された液晶表示装置。

【請求項17】 基板上に第1分離層を形成する第1工程と、

前記第1分離層上に薄膜デバイスを含む被転写層を形成する第2工程と、

40 前記被転写層上に水溶性または有機溶剤溶融性接着剤から成る第2分離層を形成する第3工程と、

前記第2分離層上に一次転写体を接合する第4工程と、前記第1分離層を境にして、前記被転写層より前記基板を除去する第5工程と、

前記被転写層の下面に二次転写体を接合する第6工程と、

前記第2分離層を水または有機溶剤と接触させて、前記第2分離層を境にして、前記被転写層より前記一次転写体を除去する第7工程と、

50 を有し、前記薄膜デバイスを含む前記被転写層を二次転

写体に転写することを特徴とする薄膜デバイスの転写方法。

【請求項18】 基板上に第1分離層を形成する第1工程と、

前記第1分離層上に薄膜デバイスを含む被転写層を形成する第2工程と、

前記被転写層上に加熱または紫外線照射により剥離作用を有する接着剤から成る第2分離層を形成する第3工程と、

前記第2分離層上に一次転写体を接合する第4工程と、前記第1分離層を境にして、前記被転写層より前記基板を除去する第5工程と、

前記被転写層の下面に二次転写体を接合する第6工程と、

前記第2分離層を加熱または紫外線照射して、前記第2分離層を境にして、前記被転写層より前記一次転写体を除去する第7工程と、

を有し、前記薄膜デバイスを含む前記被転写層を二次転写体に転写することを特徴とする薄膜デバイスの転写方法。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】 本発明は、薄膜デバイスの剥離方法、薄膜デバイスの転写方法、薄膜デバイス、アクティブマトリクス基板および液晶表示装置に関する。

【0002】

【背景技術】 例えば、薄膜トランジスタ（TFT）を用いた液晶ディスプレイを製造するに際しては、基板上に薄膜トランジスタをCVD等により形成する工程を経る。薄膜トランジスタを基板上に形成する工程は高温処理を伴うため、基板は耐熱性に優れる材質のもの、すなわち、軟化点および融点が高いものを使用する必要がある。そのため、現在では、1000°C程度の温度に耐える基板としては石英ガラスが使用され、500°C前後の温度に耐える基板としては耐熱ガラスが使用されている。

【0003】 上述のように、薄膜デバイスを搭載する基板は、それらの薄膜デバイスを製造するための条件を満足するものでなければならない。つまり、使用する基板は、搭載されるデバイスの製造条件を必ず満たすように決定される。

【0004】 しかし、TFT等の薄膜デバイスを搭載した基板が完成した後の段階のみに着目すると、上述の「基板」が必ずしも好ましくないこともある。

【0005】 例えば、上述のように、高温処理を伴う製造プロセスを経る場合には、石英基板や耐熱ガラス基板等が用いられるが、これらは非常に高価であり、したがって製品価格の上昇を招く。

【0006】 また、ガラス基板は重く、割れやすいという性質をもつ。パームトップコンピュータや携帯電話機

等の携帯用電子機器に使用される液晶ディスプレイでは、可能な限り安価で、軽くて、多少の変形にも耐え、かつ落としても壊れにくいのが望ましいが、現実には、ガラス基板は重く、変形に弱く、かつ落下による破壊の恐れがあるのが普通である。

【0007】 つまり、製造条件からくる制約と製品に要求される好ましい特性との間に溝があり、これら双方の条件や特性を満足させることは極めて困難であった。

【0008】 そこで本願出願人は、薄膜デバイスを従来のプロセスにて第1の基板上に形成した後に、この薄膜デバイスを第1の基板から剥離して、第2の基板に転写させる技術を提案している（特願平8-225643号）。このために、第1の基板と被転写層である薄膜デバイスとの間に、分離層を形成している。この分離層に例えば光を照射することで、第1の基板から被転写層である薄膜デバイスを剥離させ、この被転写層を第2の基板側に転写させている。

【0009】

【発明が解決しようとする課題】 本発明者の実験によれば、第1基板から薄膜デバイスを剥離させる際に、分離層に例えば光を照射しただけでは十分に分離層にて剥離現象が生じない場合があることが発見された。

【0010】 そして、本発明者の観察研究によれば、この剥離現象が生じやすいか否かは、分離層の性質に依存することが判明した。

【0011】 さらに、被転写層を製造する時に用いた第1の基板に対する被転写層の積層関係と、その被転写層の転写先である第2の基板に対する被転写層の積層関係とは、互いに異なってしまうという課題があった。

【0012】 そこで、本発明は、分離層に剥離に剥離現象を生じさせる工程の前に、分離層が剥離し易い状態になることを補償して、基板から薄膜デバイスを容易に剥離させるようにした薄膜デバイスの剥離方法並びにそれを用いて製造される薄膜デバイス、アクティブマトリクス基板および液晶表示装置を提供することにある。

【0013】 本発明の他の目的は、被転写層の製造時に用いた基板に対する被転写層の積層関係と、その被転写層の転写先である転写体に対する被転写層の積層関係とを一致させることができる薄膜デバイスの転写方法を提供することにある。

【0014】

【課題を解決するための手段】 請求項1に記載の発明は、基板上に分離層を形成する第1工程と、前記分離層上に薄膜デバイスを形成する第2工程と、前記分離層の層内および／または界面において剥離現象を生じさせて、前記基板を前記分離層から剥離させる第3工程と、を有する薄膜デバイスの剥離方法において、前記第3工程の前に、前記分離層にイオンを注入するイオン注入工程を設けたことを特徴とする。

【0015】 デバイス製造における信頼性が高い例え

石英基板などの基板上に、例えば、光を吸収する特性をもつ分離層を設けておき、その基板上にTFT等の薄膜デバイスを形成する。好ましくは次に、例えば接着層を介して薄膜デバイスを所望の転写体に接合しておく。その後に分離層に例えれば光を照射し、その分離層において剥離現象を生じせしめる。これにより、例えば基板に力を加えることで、薄膜デバイスを基板から剥離させることができる。

【0016】このとき、剥離工程の前にイオンを分離層に注入しておくことで、剥離工程における分離層の剥離現象が顕著となり、薄膜デバイスを確実に基板より剥離させることができる。

【0017】ここで、イオンを分離層に予め注入することで、請求項2～5のいずれかに定義された作用がなされて、分離層の剥離現象が顕著となる。

【0018】請求項2によれば、前記3工程に、前記分離層に注入された前記イオンが気体化される工程が含まれる。分離層内のイオンが気体化されると、分離層内に内圧が生じてその剥離現象が促進される。

【0019】この場合、請求項3に示すように、分離層に光を照射し、その光によって剥離用イオンを気体化させることができる。このとき、基板の裏面側より光照射すると、薄膜デバイス層に光入射される光量を低減することができ、その特性の劣化を防止できる。

【0020】請求項4によれば、前記イオン注入工程では、前記イオンにより前記分離層を構成する原子または分子の結合を切断して、前記分離層に予めダメージを与える。従って、その後の剥離工程にて生ずる分離層での剥離現象が促進される。

【0021】請求項5によれば、前記イオン注入工程では、前記イオンにより前記分離層の特性を変化させて、前記分離層と前記基板との密着性を予め弱めておく。従って、その後の剥離工程にて生ずる分離層での剥離現象が促進される。

【0022】請求項6の発明は、請求項1乃至5のいずれかにおいて、前記第2工程は、薄膜トランジスタを形成するための薄膜トランジスタ形成工程を有し、前記薄膜トランジスタ形成工程はチャネル層形成工程を含み、前記イオン注入工程は、前記チャネル層形成工程の後に実施されることを特徴とする。

【0023】チャネル形成工程は、他の工程と比較して高温処理工程となる。従って、その前に剥離現象促進用イオンを分離層に注入しておくと、その後の高温処理時にイオンが分離層から放出される虞があるからである。

【0024】請求項7の発明は、請求項6において、前記薄膜トランジスタ形成工程は、前記チャネル層形成工程後にチャネルパターン形成工程を含み、前記イオン注入工程は、前記チャネルパターン形成工程の後に実施されることを特徴とする。

【0025】チャネルパターンを形成しておくと、たと

え剥離現象促進用イオンをチャネルパターン側から注入しても、その注入の障害となり得るチャネルパターン自体の面積が少なくなる。従って、イオンを分離層まで到達させやすくなる。

【0026】請求項8の発明は、請求項6または7において、前記イオン注入工程は、前記チャネル層のうちチャネル領域となる領域上にマスクを形成して実施されることを特徴とする。

【0027】チャネル領域にイオンが注入されると、トランジスタ特性が劣化する虞があるからである。なお、チャネル領域をマスクしてイオン注入する工程は、チャネルパターン形成前でも形成後でもよい。

【0028】請求項9において、請求項7において、前記薄膜トランジスタ形成工程は、前記チャネルパターン形成工程後に、該チャネルパターン上にゲート絶縁膜を形成する工程と、該ゲート絶縁膜上にゲート電極を形成する工程と、を含み、前記ゲート電極をマスクとして前記イオン注入工程を実施することを特徴とする。

【0029】ゲート電極はチャネルと対向する位置に形成されるので、チャネル領域にイオンがチャネル領域に注入するのを防止するマスクとして、ゲート電極を兼用できる。なお、イオンの加速電圧に応じて、ゲート電極上にさらにマスクを形成しても良い。

【0030】請求項10の発明は、請求項8または9において、前記イオン注入工程は、前記チャネルパターン内のソース領域及びドレイン領域の少なくとも一方に打ち込まれる不純物イオンと、それよりも質量が軽く前記分離層に打ち込まれる前記イオンとを、同時に注入することを特徴とする。

【0031】こうすると、分離層へのイオン注入工程と、ソース及び／又はドレイン領域への不純物イオン注入工程とを兼用できる。なお、イオンは、不純物イオンよりも質量が軽いので、ソース、ドレイン領域よりも深い位置にある分離層まで到達できる。

【0032】請求項11の発明は、請求項6において、前記薄膜トランジスタ形成工程は、前記チャネル層としてアモルファシリコン層を形成する工程と、その後前記アモルファシリコン層をレーザアニールして結晶化させる結晶化工程と、を含み、前記イオン注入工程は、前記結晶化工程の前に実施されることを特徴とする。

【0033】イオン注入工程の実施により、万チャネル層にダメージが生じても、その後のレーザアニール工程によって結晶性を高められる。

【0034】請求項12の発明は、請求項1乃至11のいずれかにおいて、前記イオンは水素イオンであることを特徴とする。

【0035】水素イオンが分離層に注入されると、請求項2～4のそれぞれに示した作用に寄与させることができる。特に、水素イオンは、ソース、ドレインに打ち込まれる不純物イオン（ボロン、リンなど）よりも質量が

軽いので、請求項9の発明の実施にも適している。なお、主に請求項2の気体化を生じさせるイオンとしては水素イオンの他に窒素イオンなどを挙げることができる。また、主に請求項3、4のダメージあるいは密着性低下を生じさせるイオンとしては水素イオンの他にS iイオンなどを挙げができる。

【0036】請求項13の発明は、請求項12において、前記イオン注入工程後に実施される工程のプロセス温度を、350℃未満としたことを特徴とする。

【0037】分離層に注入された水素は、350℃以上に加熱されることで抜け始めるので、350℃以上のプロセス温度を必要とする工程は、分離層へのイオン注入工程前に実施することが好ましい。

【0038】請求項14の発明は、請求項1乃至13のいずれかに載の剥離方法を用いて前記基板より剥離されて成る薄膜デバイスを定義している。この薄膜デバイスは、分離層からの剥離が容易であるので、剥離時に作用する機械的圧力が少なくて済み、その負荷の大きさに依存する欠陥を少なくすることができる。

【0039】請求項15の発明は、マトリクス状に配置された薄膜トランジスタと、その薄膜トランジスタの一端に接続された画素電極とを含んで画素部が構成されるアクティブマトリクス基板であって、請求項6乃至13のいずれかに記載の方法を用いて前記画素部の薄膜トランジスタを転写することにより製造されたアクティブマトリクス基板を定義している。

【0040】このアクティブマトリクス基板もまた、請求項13の発明と同様に欠陥を少なくすることができる。

【0041】請求項16の発明は、請求項15に記載のアクティブマトリクス基板を用いて製造された液晶表示装置を定義している。

【0042】この液晶表示装置は、請求項15のアクティブマトリクス基板を用いていることから、液晶表示装置全体としての欠陥も少なくなる。

【0043】請求項17の発明に係る薄膜デバイスの転写方法は、基板上に第1分離層を形成する第1工程と、前記第1分離層上に薄膜デバイスを含む被転写層を形成する第2工程と、前記被転写層上に水溶性または有機溶剤溶融性接着剤から成る第2分離層を形成する第3工程と、前記第2分離層上に一次転写体を接合する第4工程と、前記第1分離層を境にして、前記被転写層より前記基板を除去する第5工程と、前記被転写層の下面に二次転写体を接合する第6工程と、前記第2分離層を水または有機溶剤と接触させて、前記第2分離層を境にして、前記被転写層より前記一次転写体を除去する第7工程と、を有し、前記薄膜デバイスを含む前記被転写層を二次転写体に転写することを特徴とする。

【0044】請求項17の発明によれば、被転写層の下面より第1分離層を除去し、その下面に二次転写体を接

合した後に、第2分離層を境にして、一次転写体を被転写層より離脱させている。こうすると、被転写層に対して、当初の基板が位置していた場所に二次転写体が存在することになり、当初の基板に対する被転写層の積層関係と、二次転写体に対する被転写層の積層関係とが一致する。ここで、第2分離層として水溶性接着剤または有機溶剤溶融性接着剤を用いていることから、一次転写体を離脱させるのに第2分離層を水または有機溶剤と接触させるだけでよい。

10 【0045】請求項18の発明に係る薄膜デバイスの転写方法では、請求項17の方法発明中の第2分離層として、上記接着剤に代えて、加熱または紫外線により剥離可能な接着剤を用いている。

【0046】この場合、一次転写体を離脱させるのに第2分離層を加熱または紫外線により剥離可能な接着剤と接触させれば、請求項17の発明と同様に、当初の基板に対する被転写層の積層関係と、二次転写体に対する被転写層の積層関係とを一致させることができる。

【0047】

20 20 【発明の実施の形態】次に、本発明の実施の形態について図面を参照して説明する。

【0048】<第1の実施の形態>図1～図6は本発明の前提となる薄膜デバイスの転写方法を説明するための図である。

【0049】[工程1]図1に示すように、基板100上に分離層（光吸収層）120を形成する。

【0050】以下、基板100および分離層120について説明する。

【0051】①基板100についての説明

30 基板100は、光が透過し得る透光性を有するものを使用する。

【0052】この場合、光の透過率は10%以上であるのが好ましく、50%以上であるのがより好ましい。この透過率が低過ぎると、光の減衰（ロス）が大きくなり、分離層120を剥離するのにより大きな光量を必要とする。

【0053】また、基板100は、信頼性の高い材料で構成されているのが好ましく、特に、耐熱性に優れた材料で構成されているのが好ましい。その理由は、例えば

40 後述する被転写層140や中間層142を形成する際に、その種類や形成方法によってはプロセス温度が高くなる（例えば350～1000℃程度）ことがあるが、その場合でも、基板100が耐熱性に優れていれば、基板100上への被転写層140等の形成に際し、その温度条件等の成膜条件の設定の幅が広がるからである。

【0054】従って、基板100は、被転写層140の形成の際の最高温度をT_{max}としたとき、歪点がT_{max}以上の材料で構成されているのものが好ましい。具体的には、基板100の構成材料は、歪点が350℃以上のものが好ましく、500℃以上のものがより好ましい。こ

のようなものとしては、例えば、石英ガラス、コーニング7059、日本電気ガラスOA-2等の耐熱性ガラスが挙げられる。

【0055】また、基板100の厚さは、特に限定されないが、通常は、0.1~5.0mm程度であるのが好ましく、0.5~1.5mm程度であるのがより好ましい。基板100の厚さが薄すぎると強度の低下を招き、厚すぎると、基板100の透過率が低い場合に、光の減衰を生じ易くなる。なお、基板100の光の透過率が高い場合には、その厚さは、前記上限値を超えるものであってもよい。なお、光を均一に照射できるように、基板100の厚さは、均一であるのが好ましい。

【0056】②分離層120の説明

分離層120は、物理的作用（光、熱など）、化学的作用（薬液等との化学反応など）あるいは機械的作用（引っ張り力、振動など）のいずれか一つあるいは複数の作用を受けることで、その結合力が減少されあるいは消滅され、それによりこの分離層120を介して基板100の分離を促すものである。

【0057】この分離層120として例えば、照射される光を吸収し、その層内および／または界面において剥離（以下、「層内剥離」、「界面剥離」と言う）を生じるような性質を有するものを挙げることができる。好ましくは、光の照射により、分離層120を構成する物質の原子間または分子間の結合力が消失または減少すること、すなわち、アブレーションが生じて層内剥離および／または界面剥離に至るもののがよい。

【0058】さらに、光の照射により、分離層120から気体が放出され、分離効果が発現される場合もある。すなわち、分離層120に含有されていた成分が気体となって放出される場合と、分離層120が光を吸収して一瞬気体になり、その蒸気が放出され、分離に寄与する場合とがある。

【0059】本発明では、このような特性を有する分離層120を形成後に、分離層120内に剥離促進用イオンを注入することが特徴であり、それによりその後の工程での分離層120での剥離現象を促進させるものである。従って、剥離促進用イオンとしては、上述した物理的作用、化学的作用あるいは機械的作用による剥離現象を促進させるものであれば種類は問わない。

【0060】次に、このような分離層120の組成としては、例えば、次のA~Eに記載されるものが挙げられる。

【0061】A. アモルファスシリコン (a-Si)
このアモルファスシリコン中には、水素 (H) が含有されていてもよい。この場合、Hの含有量は、2原子%以上程度であるのが好ましく、2~20原子%程度であるのがより好ましい。このように、水素 (H) が所定量含有されていると、後に光が照射されることによって水素が放出され、分離層120に内圧が発生し、それが上

下の薄膜を剥離する力となる。アモルファスシリコン中の水素 (H) の含有量は、成膜条件、例えばCVDにおけるガス組成、ガス圧、ガス雰囲気、ガス流量、温度、基板温度、投入パワー等の条件を適宜設定することにより調整することができる。

【0062】本実施の形態では、このプロセス条件によって分離層120中に水素を含有させる他に、後述する通り、アモルファスシリコン層の形成後のいずれかの時期に、剥離促進用イオンとして水素イオンをイオン注入することができる。これにより、アモルファスシリコンのプロセス条件に左右されずに、一定量以上の水素をアモルファスシリコン層内に含有させることができる。

【0063】B. 酸化ケイ素又はケイ酸化合物、酸化チタンまたはチタン酸化合物、酸化ジルコニウムまたはジルコン酸化合物、酸化ランタンまたはランタン酸化化合物等の各種酸化物セラミックス、透電体（強誘電体）あるいは半導体

酸化ケイ素としては、SiO、SiO₂、Si₃O₂が挙げられ、ケイ酸化合物としては、例えばK₂SiO₃、Li₂SiO₃、CaSiO₃、ZrSiO₄、Na₂SiO₃が挙げられる。

【0064】酸化チタンとしては、TiO、Ti₂O₃、TiO₂が挙げられ、チタン酸化合物としては、例えば、BaTiO₄、BaTiO₃、Ba₂Ti₉O₂₀、BaTi₅O₁₁、CaTiO₃、SrTiO₃、PbTiO₃、MgTiO₃、ZrTiO₂、SnTiO₄、Al₂TiO₅、FeTiO₃が挙げられる。

【0065】酸化ジルコニウムとしては、ZrO₂が挙げられ、ジルコン酸化合物としては、例えばBaZrO₃、ZrSiO₄、PbZrO₃、MgZrO₃、K₂ZrO₃が挙げられる。

【0066】C. PZT、PLZT、PLLZT、PBZT等のセラミックスあるいは誘電体（強誘電体）
D. 窒化珪素、窒化アルミ、窒化チタン等の窒化物セラミックス

E. 有機高分子材料

有機高分子材料としては、-CH-、-CO-（ケトン）、-CONH-（アミド）、-NH-（イミド）、-COO-（エステル）、-N=N-（アゾ）、-CH=N-（シフ）等の結合（光の照射によりこれらの結合が切断される）を有するもの、特に、これらの結合を多く有するものであればいかなるものでもよい。また、有機高分子材料は、構成式中に芳香族炭化水素（1または2以上のベンゼン環またはその縮合環）を有するものであってもよい。

【0067】このような有機高分子材料の具体例としては、ポリエチレン、ポリプロピレンのようなポリオレフィン、ポリイミド、ポリアミド、ポリエステル、ポリメチルメタクリレート（PMMA）、ポリフェニレンサルファイド（PPS）、ポリエーテルスルホン（PE

S)、エポキシ樹脂等があげられる。

【0068】F. 金属

金属としては、例えば、Al, Li, Ti, Mn, In, Sn, Y, La, Ce, Nd, Pr, Gd, Smまたはこれらのうちの少なくとも1種を含む合金が挙げられる。

【0069】また、分離層120の厚さは、剥離目的や分離層120の組成、層構成、形成方法等の諸条件により異なるが、通常は、1nm～20μm程度であるのが好ましく、5nm～2μm程度であるのがより好ましく、5nm～1μm程度であるのがさらに好ましい。分離層120の膜厚が小さすぎると、成膜の均一性が損なわれ、剥離にムラが生じることがあり、また、膜厚が厚すぎると、分離層120の良好な剥離性を確保するためには、光のパワー（光量）を大きくする必要があるとともに、後に分離層120を除去する際に、その作業に時間がかかる。なお、分離層120の膜厚は、できるだけ均一であるのが好ましい。

【0070】分離層120の形成方法は、特に限定されず、膜組成や膜厚等の諸条件に応じて適宜選択される。たとえば、CVD（MOCVD、低圧CVD、ECR-CVDを含む）、蒸着、分子線蒸着（MB）、スパッタリング、イオンプレーティング、PVD等の各種気相成膜法、電気メッキ、浸漬メッキ（ディッピング）、無電解メッキ等の各種メッキ法、ラングミュア・プロジェクト（LB）法、スピンドルコート、スプレーコート、ロールコート等の塗布法、各種印刷法、転写法、インクジェット法、粉末ジェット法等が挙げられ、これらのうちの2以上を組み合わせて形成することもできる。

【0071】例えば、分離層120の組成がアモルファスシリコン（a-Si）の場合には、CVD、特に低圧CVDやプラズマCVDにより成膜するのが好ましい。

【0072】また、分離層120をジルゲル法によるセラミックスで構成する場合や、有機高分子材料で構成する場合には、塗布法、特に、スピンドルコートにより成膜するのが好ましい。

【0073】[工程2]次に、図2に示すように、分離層120上に、被転写層（薄膜デバイス層）140を形成する。この工程2以降の詳細は、後に図8～図18を参照して説明するが、本実施の形態では、図8～図13の工程途中にて、分離層120への剥離促進用イオン注入工程を実施している。

【0074】この薄膜デバイス層140のK部分（図2において1点線鎖線で囲んで示される部分）の拡大断面図を、図2の右側に示す。図示されるように、薄膜デバイス層140は、例えば、SiO₂膜（中間層）142上に形成されたTFT（薄膜トランジスタ）を含んで構成され、このTFTは、ポリシリコン層にn型不純物を導入して形成されたソース、ドレイン層146と、チャネル層144と、ゲート絶縁膜148と、ゲート電極1

50と、層間絶縁膜154と、例えばアルミニウムからなる電極152とを具備する。

【0075】本実施の形態では、分離層120に接して設けられる中間層としてSiO₂膜を使用しているが、Si₃N₄などのその他の絶縁膜を使用することもできる。SiO₂膜（中間層）の厚みは、その形成目的や発揮し得る機能の程度に応じて適宜決定されるが、通常は、10nm～5μm程度であるのが好ましく、40nm～1μm程度であるのがより好ましい。中間層は、種々の目的で形成され、例えば、被転写層140を物理的または化学的に保護する保護層、絶縁層、導電層、レーザー光の遮光層、マイグレーション防止用のバリア層、反射層としての機能の内の少なくとも1つを発揮するものが挙げられる。

【0076】なお、場合によっては、SiO₂膜等の中間層を形成せず、分離層120上に直接被転写層（薄膜デバイス層）140を形成してもよい。

【0077】被転写層140（薄膜デバイス層）は、図2の右側に示されるようなTFT等の薄膜デバイスを含む層である。

【0078】薄膜デバイスとしては、TFTの他に、例えば、薄膜ダイオードや、シリコンのPIN接合からなる光電変換素子（光センサ、太陽電池）やシリコン抵抗素子、その他の薄膜半導体デバイス、電極（例：ITO、メサ膜のような透明電極）、スイッチング素子、メモリー、圧電素子等のアクチュエータ、マイクロミラー（ピエゾ薄膜セラミックス）、磁気記録薄膜ヘッド、コイル、インダクター、薄膜高透磁材料およびそれらを組み合わせたマイクロ磁気デバイス、フィルター、反射膜、ダイクロイックミラー等がある。

【0079】このような薄膜デバイスは、その形成方法との関係で、通常、比較的高いプロセス温度を経て形成される。したがって、この場合、前述したように、基板100としては、そのプロセス温度に耐え得る信頼性の高いものが必要となる。

【0080】[工程3]次に、図3に示すように、薄膜デバイス層140を、接着層160を介して転写体180に接合（接着）する。

【0081】接着層160を構成する接着剤の好適な例としては、反応硬化型接着剤、熱硬化型接着剤、紫外線硬化型接着剤等の光硬化型接着剤、嫌気硬化型接着剤等の各種硬化型接着剤が挙げられる。接着剤の組成としては、例えば、エポキシ系、アクリレート系、シリコーン系等、いかなるものでもよい。このような接着層160の形成は、例えば、塗布法によりなされる。

【0082】前記硬化型接着剤を用いる場合、例えば被転写層（薄膜デバイス層）140上に硬化型接着剤を塗布し、その上に転写体180を接合した後、硬化型接着剤の特性に応じた硬化方法により前記硬化型接着剤を硬化させて、被転写層（薄膜デバイス層）140と転写体

180とを接着し、固定する。

【0083】接着剤が光硬化型の場合、光透過性の基板100または光透過性の転写体180の一方の外側から（あるいは光透過性の基板及び転写体の両外側から）光を照射する。接着剤としては、薄膜デバイス層に影響を与えるにくい紫外線硬化型などの光硬化型接着剤が好ましい。

【0084】接着層160として、水溶性接着剤を用いることもできる。この種の水溶性接着剤として、例えばケミテック株式会社製のケミシールU-451D（商品名）、株式会社スリーボンド製のスリーボンド3046（商品名）などを挙げることができる。

【0085】接着層160として、各種の有機溶剤に対して溶融性のある接着剤を用いることもできる。

【0086】接着層160として、加熱により剥離作用を呈する接着剤を用いることもできる。この種の接着剤として、例えば日東デンコー製のリバアルファ（商品名）を用いることができる。

【0087】接着層160として、紫外線照射により剥離作用を呈する接着剤を用いることもできる。この種の接着剤として、例えばリンテック株式会社製のガラス・セラミック用ダイシングテープD-210, D-636を用いることができる。

【0088】なお、図示と異なり、転写体180側に接着層160を形成し、その上に被転写層（薄膜デバイス層）140を接着してもよい。なお、例えば転写体180自体が接着機能を有する場合等には、接着層160の形成を省略してもよい。

【0089】転写体180としては、特に限定されないが、基板（板材）、特に透明基板が挙げられる。なお、このような基板は平板であっても、湾曲板であってもよい。また、転写体180は、前記基板100に比べ、耐熱性、耐食性等の特性が劣るものであってもよい。その理由は、本発明では、基板100側に被転写層（薄膜デバイス層）140を形成し、その後、被転写層（薄膜デバイス層）140を転写体180に転写するため、転写体180に要求される特性、特に耐熱性は、被転写層（薄膜デバイス層）140の形成の際の温度条件等に依存しないからである。

【0090】したがって、被転写層140の形成の際の最高温度をT_{max}としたとき、転写体0の構成材料として、ガラス転移点（T_g）または軟化点がT_{max}以下のものを用いることができる。例えば、転写体180は、ガラス転移点（T_g）または軟化点が好ましくは800℃以下、より好ましくは500℃以下、さらに好ましくは320℃以下の材料で構成することができる。

【0091】また、転写体180の機械的特性としては、ある程度の剛性（強度）を有するものが好ましいが、可撓性、弾性を有するものであってもよい。

【0092】このような転写体180の構成材料として

は、各種合成樹脂または各種ガラス材が挙げられ、特に、各種合成樹脂や通常の（低融点の）安価なガラス材が好ましい。

【0093】合成樹脂としては、熱可塑性樹脂、熱硬化性樹脂のいずれでもよく、例えば、ポリエチレン、ポロプロピレン、エチレン-ブレピレン共重合体、エチレン-酢酸ビニル共重合体（EVA）等のポリオレフィン、環状ポリオレフィン、変性ポリオレフィン、ポリ塩化ビニル、ポリ塩化ビニリデン、ポリスチレン、ポリアミド、ポリイミド、ポリアミドイミド、ポリカーボネート、ポリー（4-メチルベンゼンテニ-1）、アイオノマー、アクリル系樹脂、ポリメチルメタクリレート、アクリルースチレン共重合体（AS樹脂）、ブタジエン-スチレン共重合体、ポリオ共重合体（EVOH）、ポリエチレンテレフタレート（PET）、ポリブチレンテレフタレート（PBT）、ブリシクロヘキサンテレフタレート（PCT）等のポリエステル、ポリエーテル、ポリエーテルケトン（PEK）、ポリエーテルエーテルケトン（PEEK）、ポリエーテルイミド、ポリアセタール（POM）、ポリフェニレンオキシド、変性ポリフェニレンオキシド、ポリアリレート、芳香族ポリエステル（液晶ポリマー）、ポリテトラフルオロエチレン、ポリフッ化ビニリデン、その他フッ素系樹脂、スチレン系、ポリオレフィン系、ポリ塩化ビニル系、ポリウレタン系、フッ素ゴム系、塩素化ポリエチレン系等の各種熱可塑性エラストマー、エボキシ樹脂、フェノール樹脂、ユリア樹脂、メラミン樹脂、不飽和ポリエステル、シリコーン樹脂、ポリウレタン等、またはこれらを主とする共重合体、ブレンド体、ポリマー-アロイ等が挙げられ、これらのうちの1種または2種以上を組み合わせて（例えば2層以上の積層体として）用いることができる。

【0094】ガラス材としては、例えば、ケイ酸ガラス（石英ガラス）、ケイ酸アルカリガラス、ソーダ石灰ガラス、カリ石灰ガラス、鉛（アルカリ）ガラス、バリウムガラス、ホウケイ酸ガラス等が挙げられる。このうち、ケイ酸ガラス以外のものは、ケイ酸ガラスに比べて融点が低く、また、成形、加工も比較的容易であり、しかも安価であり、好ましい。

【0095】転写体180として合成樹脂で構成されたものを用いる場合には、大型の転写体180を一体的に成形することができるとともに、湾曲面や凹凸を有するもの等の複雑な形状であっても容易に製造することができ、また、材料コスト、製造コストも安価であるという種々の利点が享受できる。したがって、合成樹脂の使用は、大型で安価なデバイス（例えば、液晶ディスプレイ）を製造する上で有利である。

【0096】なお、転写体180は、例えば、液晶セルのように、それ自体独立したデバイスを構成するものや、例えばカラーフィルター、電極層、誘電体層、絶縁層、半導体素子のように、デバイスの一部を構成するも

のであってもよい。

【0097】さらに、転写体180は、金属、セラミックス、石材、木材紙等の物質であってもよいし、ある品物を構成する任意の面上（時計の面上、エアコンの表面上、プリント基板の上等）、さらには壁、柱、天井、窓ガラス等の構造物の表面上であってもよい。

【0098】[工程4]次に、図4に示すように、基板100の裏面側から光を照射する。

【0099】この光は、基板100を透過した後に分離層120に照射される。これにより、分離層120に層内剥離および／または界面剥離が生じ、結合力が減少または消滅する。

【0100】分離層120の層内剥離および／または界面剥離が生じる原理は、分離層120の構成材料にアブレーションが生じること、また、分離層120に含まれているガスの放出、さらには照射直後に生じる溶融、蒸散等の相変化によるものであることが推定される。

【0101】ここで、アブレーションとは、照射光を吸収した固定材料（分離層120の構成材料）が光化学的または熱的に励起され、その表面や内部の原子または分子の結合が切断されて放出することをいい、主に、分離層120の構成材料の全部または一部が溶融、蒸散（気化）等の相変化を生じる現象として現れる。また、前記相変化によって微小な発砲状態となり、結合力が低下することもある。

【0102】分離層120が層内剥離を生じるか、界面剥離を生じるか、またはその両方であるかは、分離層120の組成や、その他種々の要因に左右され、その要因の1つとして、照射される光の種類、波長、強度、到達深さ等の条件が挙げられる。

【0103】ここで、本実施の形態では、分離層120の形成後に、この第4工程にて分離層120自体に剥離現象をより確実に生じさせるために、剥離促進用イオンが注入されている。

【0104】この剥離促進用イオンは、少なくとも以下の3つのいずれか或いは2つ以上の組合せの作用をなし、第4工程における分離層120の剥離現象を促進させる。

【0105】その一つは、この第4工程の実施により、分離層120に注入された剥離促進用イオン例えは水素（H）あるいは窒素（N）が気体化され、それにより分離層120の剥離が促進される。

【0106】他の一つは、剥離促進用イオン注入工程において、その剥離促進用イオン例えは水素（H）、窒素（N）あるいはシリコン（Si）により分離層120を構成する原子または分子の結合を切断して、分離層120に予めダメージを与えている。従って、予めダメージが与えられた分離層120では、第4工程の実施により比較的容易に剥離が生ずる。

【0107】さらに他の一つは、剥離促進用イオン注入

工程において、その剥離促進用イオン例えは水素

（H）、窒素（N）あるいはシリコン（Si）により分離層120の特性を変化させて、分離層120と基板100との密着性が予め弱められている。この場合にも、基板との密着性が弱められた分離層120では、第4工程の実施により比較的容易に剥離が生ずる。

【0108】第4工程にて照射される光としては、分離層120に層内剥離および／または界面剥離を起こさせるものであればいかなるものでもよく、例えば、X線、紫外線、可視光、赤外線（熱線）、レーザ光、ミリ波、マイクロ波、電子線、放射線（ α 線、 β 線、 γ 線）等が挙げられる。そのなかでも、分離層120の剥離（アブレーション）を生じさせやすいという点で、レーザ光が好ましい。

【0109】このレーザ光を発生させるレーザ装置としては、各種気体レーザ、固体レーザ（半導体レーザ）等が挙げられるが、エキシマレーザ、Nd-YAGレーザ、Arレーザ、CO₂レーザ、COレーザ、He-Neレーザ等が好適に用いられ、その中でもエキシマレーザが特に好ましい。

【0110】エキシマレーザは、短波長域で高エネルギーを出力するため、極めて短時間で分離層120にアブレーションを生じさせることができ、よって隣接する転写体180や基板100等に温度上昇をほとんど生じさせることなく、すなわち劣化、損傷を生じさせることなく、分離層120を剥離することができる。

【0111】また、分離層120にアブレーションを生じさせるに際して、光の波長依存性がある場合、照射されるレーザ光の波長は、100nm～350nm程度であるのが好ましい。

【0112】図7に、基板100の、光の波長に対する透過率の一例を示す。図示されるように、200nmの波長に対して透過率が急峻に増大する特性をもつ。このような場合には、210nm以上の波長の光、例えば、Xe-C₁エキシマレーザー光（波長308nm）、KrFレーザー光（波長248nm）などを照射する。

【0113】また、分離層120に、例えはガス放出、気化、昇華等の相変化を起こさせて分離特性を与える場合、照射されるレーザ光の波長は、350から1200nm程度であるのが好ましい。

【0114】また、照射されるレーザ光のエネルギー密度、特に、エキシマレーザの場合のエネルギー密度は、10～5000mJ/cm²程度とするのが好ましく、100～500mJ/cm²程度とするのがより好ましい。また、照射時間は、1～1000nsec程度とするのが好ましく、10～100nsec程度とするのがより好ましい。エネルギー密度が低いかまたは照射時間が短いと、十分なアブレーション等が生じず、また、エネルギー密度が高いかまたは照射時間が長いと、分離層120を透過した照射光により被転写層140に悪影響

を及ぼすおそれがある。

【0115】なお、分離層120を透過した照射光が被転写層140にまで達して悪影響を及ぼす場合の対策としては、例えば、図30に示すように、分離層（レーザー吸収層）120上にタンタル（Ta）等の金属膜124を形成する方法がある。これにより、分離層120を透過したレーザー光は、金属膜124の界面で完全に反射され、それより上の薄膜デバイスに悪影響を与えない。

【0116】次に、図5に示すように、基板100に力を加えて、この基板100を分離層120から離脱させる。図5では図示されないが、この離脱後、基板100上に分離層が付着することもある。

【0117】次に、図6に示すように、残存している分離層120を、例えば洗浄、エッティング、アッシング、研磨等の方法またはこれらを組み合わせた方法により除去する。これにより、被転写層（薄膜デバイス層）140が、転写体180に転写されることになる。

【0118】なお、離脱した基板100にも分離層の一部が付着している場合には同様に除去する。なお、基板100が石英ガラスのような高価な材料、希少な材料で構成されている場合等には、基板100は、好ましくは再利用（リサイクル）に供される。すなわち、再利用したい基板100に対し、本発明を適用することができ、有用性が高い。

【0119】以上のような各工程を経て、被転写層（薄膜デバイス層）140の転写体180への転写が完了する。その後、被転写層（薄膜デバイス層）140に隣接するSiO₂膜の除去や、被転写層140上への配線等の導電層や所望の保護膜の形成等を行うこともできる。

【0120】このように、被剥離物である被転写層（薄膜デバイス層）140自体を直接に剥離するのではなく、被転写層（薄膜デバイス層）140に接合された分離層において剥離するため、被剥離物（被転写層140）の特性、条件等にかかわらず、容易かつ確実に、しかも均一に剥離（転写）することができ、剥離操作に伴う被剥離物（被転写層140）へのダメージもなく、被転写層140の高い信頼性を維持することができる。

【0121】次に、基板100及び分離層120上に、薄膜デバイス層140として例えばCMOS構造のTFTを形成し、これを転写体に転写する場合の具体的な製造プロセスの例を図8～図18を用いて説明する。なお、このプロセス途中にて実施される剥離促進用イオン注入工程についても説明する。

【0122】（工程1）図8に示すように、透光性基板（例えば石英基板）100上に、分離層（例えば、LPCVD法により形成されたアモルファスシリコン層）120と、中間層（例えば、SiO₂膜）142と、アモルファスシリコン層（例えばLPCVD法により形成される）143とを順次に積層形成し、続いて、アモルフ

アスシリコン層143の全面に上方からレーザー光を照射し、アニールを施す。これにより、アモルファスシリコン層143は再結晶化してポリシリコン層となる。なお、この場合のレーザアニールをビームスキャンによって実施する場合には、上述の分離層120へのビームスキャンとは異なり、各回のビームのビーム中心同士が重なるように（ガウシアンビームの場合は除く）、同一箇所に2度以上光照射されることが好ましい。この場合には光漏れなどの弊害はなく、多重照射することでアモルファスシリコン層143を十分に再結晶化できるからである。

【0123】剥離促進用イオンの注入工程の実施時期としては、分離層120の形成後であって、結晶化のためのレーザアニール工程の前であれば、マスクを必要とせずにイオン注入が実施できる点で好ましい。

【0124】従って、その実施時期としては、
 (A) 図8の分離層120の形成後であって中間層142の形成前
 (B) 中間層142の形成後であってアモルファスシリコン層143の形成前

(C) アモルファスシリコン層143の形成後であって、その結晶化のためのレーザアニール工程の前

のいずれかとなる。この(A)～(C)の中では、

(C) の実施時期が最も好ましい。その理由は、アモルファスシリコン層143の形成工程すなわちチャネル層の形成工程は、現状で425℃程度のプロセス温度となる。この際、例えば剥離促進用イオンとして水素イオンを既に分離層120に注入してある場合には、水素が350℃以上の温度にて分離層120から抜け出る虞がある。従って、剥離促進用イオンの注入工程は、チャネル層形成後の実施時期(C)にて行うことが好ましい。ただし、剥離促進用イオンの種類によってはそのような制限がないため、実施時期(A) (B) でも実施可能である。また、アモルファスシリコン層143がレーザアニールされて多結晶化された後の層に、剥離促進用イオンの注入に起因したダメージが生じていないことが、トランジスタ特性上好ましい。(A) (B) の場合にはダメージの発生自体が無く、(C) の場合には、たとえアモルファスシリコン層143自体にダメージが生じたとしても、その後の結晶化工程によりそのダメージの影響が低減される。

【0125】なお、この剥離促進用イオン注入工程は、公知のイオン注入装置を用いて実施することができる。すなわち、例えば水素イオンを注入するのであれば、水素を含むガスをプラズマ化し、それによって生成された水素イオンを電界によって加速することで、分離層120に注入できる。

【0126】イオン注入工程の実施時期(D)としては、レーザアニール後であってもよい。この場合には、チャネル領域となる部分をマスクしてイオン注入すれ

ば、トランジスタ特性を劣化させることができない。なお、イオン注入工程後にマスクは除去される。に

(工程2) 続いて、図9に示すように、レーザーアニールにより得られたポリシリコン層をパターニングして、チャネルパターンとしてアイランド144a, 144bを形成する。

【0127】剥離促進用イオン注入工程は、その実施時期(E)として、上述した(A)～(D)以外にも、第2工程(チャネルパターン形成工程)後に実施することができる。この場合には、図31に示すように、アイランド144a, 144b上であって、アイランド144a, 144b内のチャネル領域と対向する部分に、マスクパターン201を形成しておく。そして、その状態で剥離促進用イオン例えば水素イオンを、分離層120に向けて注入する。これにより、チャネル領域に水素が含有されることが無く、トランジスタ特性が劣化しない。なお、剥離促進用イオン注入工程が終了したら、マスクパターン201は除去される。

【0128】(工程3) 図10に示されるように、アイランド144a, 144bを覆うゲート絶縁膜148a, 148bを、例えば、CVD法により形成する。

【0129】剥離促進用イオン注入工程は、その実施時期(F)として、上述した(A)～(E)以外にも、第3工程(ゲート絶縁膜)後に実施することができる。この場合には、図32に示すように、ゲート絶縁膜148a, 148b上であって、アイランド144a, 144b内のチャネル領域と対向する部分に、マスクパターン202を形成しておくことが好ましい。

【0130】(工程4) 図11に示されるように、ポリシリコンあるいはメタル等からなるゲート電極150a, 150bを形成する。

【0131】(工程5) 図12に示すように、ポリイミド等からなるマスク層170を形成し、ゲート電極150bおよびマスク層170をマスクとして用い、セルフアラインで、例えばボロン(B)のイオン注入を行う。これによって、p⁺層172a, 172bが形成される。

【0132】剥離促進用イオン注入工程は、その実施時期(G)として、上述した(A)～(F)以外にも、このボロンイオン注入工程と同時に実施することができる。この場合、例えばB₂H₆(5%) + H₂(95%)の混合ガスをプラズマ化し、それにより生成されたボロンイオン及び水素イオンを加速して、質量分析器を介さずに基板に導く。そうすると、同じ加速電圧であっても、質量の重いボロンイオンは上層側の多結晶シリコン層に止まる一方で、質量の軽い水素イオンはより深く打ち込まれて、分離層120まで到達する。

【0133】なお、このときゲート電極150bが図31のマスクパターン201あるいは図32のマスクパターン202と同様に機能するが、加速電圧に応じてゲー

ト電極150b上にさらにマスク層を設けることができる。

【0134】(工程6) 図13に示すように、ポリイミド等からなるマスク層174を形成し、ゲート電極150aおよびマスク層174をマスクとして用い、セルフアラインで、例えばリン(P)のイオン注入を行う。これによって、n⁺層146a, 146bが形成される。

【0135】剥離促進用イオン注入工程は、その実施時期(H)として、上述した(A)～(G)以外にも、このリンイオン注入工程と同時に実施することができる。この場合も、例えばPH₃(5%) + H₂(95%)の混合ガスをプラズマ化し、それにより生成されたリンイオン及び水素イオンを加速して、質量分析器を介さずに基板に導く。そうすると、同じ加速電圧であっても、質量の重いリンイオンは上層側の多結晶シリコン層に止まる一方で、質量の軽い水素イオンはより深く打ち込まれて、分離層120まで到達する。

【0136】なお、この場合はゲート電極150aが図31のマスクパターン201あるいは図32のマスクパターン202と同様に機能するが、加速電圧に応じてゲート電極150a上にさらにマスク層を設けることができる。

【0137】また、上記の剥離促進用イオン注入工程の実施時期(G)～(H)は、工程5及び工程6でのソース、ドレイン領域への不純物イオン注入工程と同時であったが、その前後で別個に行うものでも良い。

【0138】(工程7) 図14に示すように、層間絶縁膜154を形成し、選択的にコンタクトホール形成後、電極152a～152dを形成する。

【0139】このようにして形成されたCMOS構造のTFTが、図2～図6における被転写層(薄膜デバイス層)140に該当する。なお、層間絶縁膜154上に保護膜を形成してもよい。

【0140】(工程8) 図15に示すように、CMOS構成のTFT上に接着層としてのエポキシ樹脂層160を形成し、次に、そのエポキシ樹脂層160を介して、TFTを転写体(例えば、ソーダガラス基板)180に貼り付ける。続いて、熱を加えてエポキシ樹脂を硬化させ、転写体180とTFTとを接着(接合)する。

【0141】なお、接着層160は紫外線硬化型接着剤であるフォトポリマー樹脂でもよい。この場合は、熱ではなく転写体180側から紫外線を照射してポリマーを硬化させる。

【0142】(工程9) 図16に示すように、透光性基板100の裏面から、例えば、Xe-C₁エキシマレーザー光を照射する。これにより、分離層120の層内および/または界面において剥離を生じせしめる。

【0143】(工程10) 図17に示すように、基板100を引き剥がす。

【0144】(工程11) 最後に、分離層120をエッ

チングにより除去する。これにより、図18に示すように、CMOS構成のTFTが、転写体180に転写されたことになる。

【0145】<第2の実施の形態>次に、本発明の第2の実施の形態について、図33～図35を参照して説明する。なお、この第2の実施の形態は、薄膜デバイス層から構成される被転写層140を2度転写するものであり、第1の実施の形態の図1～図6の工程に加えて、図33～図35の工程が追加される。

【0146】ここで、この第2の実施の形態では、図2～図5に示す分離層120が第1分離層と称される。また、この第2の実施の形態では、図3～図6の接着層160が第2分離層と称される。さらに、この第2の実施の形態では、図3～図6の転写体180が一次転写体と称される。従って、この第2の実施の形態によれば、図6の工程が終了した段階では、被転写層140は第2分離層160を介して一次転写体180に転写されたことになる。

【0147】ここで、第2の実施の形態では、第2分離層160の材質は熱溶融性接着剤、水溶性接着剤だけでなく、第1分離層120と同じ材質のものを用いることができる。このとき、この第2分離層160での剥離を容易とするために、上述した第1の実施の形態にて説明したイオン注入を行うことができる。

【0148】以下、図6の工程後に実施される図33～図35の追加工程1～3について説明する。

【0149】[追加工程1]図6の工程に続いて、図33に示すように、薄膜デバイス層140の下面(露出面)に、接着層190を介して、二次転写層200を接着する。

【0150】接着層190を構成する接着剤の好適な例としては、反応硬化型接着剤、熱硬化型接着剤、紫外線硬化型接着剤等の光硬化型接着剤、嫌気硬化型接着剤等の各種硬化型接着剤が挙げられる。接着剤の組成としては、例えば、エポキシ系、アクリレート系、シリコーン系等、いかなるものでもよい。このような接着層190の形成は、例えば、塗布法によりなされる。

【0151】前記硬化型接着剤を用いる場合、例えば被転写層(薄膜デバイス層)140の下面に硬化型接着剤を塗布し、さらに二次転写層200を接合した後、硬化型接着剤の特性に応じた硬化方法により前記硬化型接着剤を硬化させて、被転写層(薄膜デバイス層)140と二次転写層200とを接着し、固定する。

【0152】接着剤が光硬化型の場合、好ましくは光透過性の二次転写層200の外側から光を照射する。接着剤としては、薄膜デバイス層に影響を与えるにくい紫外線硬化型などの光硬化型接着剤を用いれば、光透過性の一次転写体180側から、あるいは光透過性の一次、二次転写体180, 200の両側から光照射しても良い。

【0153】なお、図示と異なり、二次転写層200側

に接着層190を形成し、その上に被転写層(薄膜デバイス層)140を接着してもよい。なお、例えば二次転写層200自体が接着機能を有する場合等には、接着層190の形成を省略してもよい。

【0154】二次転写層200としては、特に限定されないが、基板(板材)、特に透明基板が挙げられる。なお、このような基板は平板であっても、湾曲板であってもよい。

【0155】また、二次転写層200は、前記基板100に比べ、耐熱性、耐食性等の特性が劣るものであってもよい。その理由は、本発明では、基板100側に被転写層(薄膜デバイス層)140を形成し、その後、被転写層(薄膜デバイス層)140を二次転写層200に転写するため、二次転写層200に要求される特性、特に耐熱性は、被転写層(薄膜デバイス層)140の形成の際の温度条件等に依存しないからである。この点は、一次転写体180についても同様である。

【0156】したがって、被転写層140の形成の際の最高温度をT_{max}としたとき、一次、二次転写体180, 200の構成材料として、ガラス転移点(T_g)または軟化点がT_{max}以下のものを用いることができる。例えば、一次、二次転写体180, 200は、ガラス転移点(T_g)または軟化点が好ましくは800℃以下、より好ましくは500℃以下、さらに好ましくは320℃以下の材料で構成することができる。

【0157】また、一次、二次転写体180, 200の機械的特性としては、ある程度の剛(強度)を有するものが好ましいが、可撓性、弾性を有するものであってもよい。

【0158】このような一次、二次転写体180, 200の構成材料としては、各種合成樹脂または各種ガラス材が挙げられ、特に、各種合成樹脂や通常の(低融点の)安価なガラス材が好ましい。

【0159】合成樹脂としては、熱可塑性樹脂、熱硬化性樹脂のいずれでもよく、例えば、ポリエチレン、ポロプロピレン、エチレン-ブレピレン共重合体、エチレン-酢酸ビニル共重合体(EVA)等のポリオレフィン、環状ポリオレフィン、変性ポリオレフィン、ポリ塩化ビニル、ポリ塩化ビニリデン、ポリスチレン、ポリアミド、ポリイミド、ポリアミドイミド、ポリカーボネート、ポリ-(4-メチルベンゼンテナー-1)、アイオノマー、アクリル系樹脂、ポリメチルメタクリレート、アクリル-ステレン共重合体(A-S樹脂)、ブタジエン-ステレン共重合体、ポリオ共重合体(EVOH)、ポリエチレンテレフタレート(PET)、ポリブチレンテレフタレート(PBT)、ブリシクロヘキサンテレフタレート(PCT)等のポリエステル、ポリエーテル、ポリエーテルケトン(PEK)、ポリエーテルエーテルケトン(PEEK)、ポリエーテルイミド、ポリアセタール(POM)、ポリフェニレンオキシド、変性ポリフェニ

レンオキシド、ポリアリレート、芳香族ポリエステル（液晶ポリマー）、ポリテトラフルオロエチレン、ポリフッ化ビニリデン、その他フッ素系樹脂、スチレン系、ポリオレフィン系、ポリ塩化ビニル系、ポリウレタン系、フッ素ゴム系、塩素化ポリエチレン系等の各種熱可塑性エラストマー、エボキシ樹脂、フェノール樹脂、ユリア樹脂、メラミン樹脂、不飽和ポリエステル、シリコーン樹脂、ポリウレタン等、またはこれらを主とする共重合体、ブレンド体、ポリマーアロイ等が挙げられ、これらのうちの1種または2種以上を組み合わせて（例えば2層以上の積層体として）用いることができる。

【0160】ガラス材としては、例えば、ケイ酸ガラス（石英ガラス）、ケイ酸アルカリガラス、ソーダ石灰ガラス、カリ石灰ガラス、鉛（アルカリ）ガラス、バリウムガラス、ホウケイ酸ガラス等が挙げられる。このうち、ケイ酸ガラス以外のものは、ケイ酸ガラスに比べて融点が低く、また、成形、加工も比較的容易であり、しかも安価であり、好ましい。

【0161】二次転写体200として合成樹脂で構成されたものを用いる場合には、大型の二次転写体200を一体的に成形することができるとともに、湾曲面や凹凸を有するもの等の複雑な形状であっても容易に製造することができ、また、材料コスト、製造コストも安価であるという種々の利点が享受できる。したがって、合成樹脂の使用は、大型で安価なデバイス（例えば、液晶ディスプレイ）を製造する上で有利である。

【0162】なお、二次転写体200は、例えば、液晶セルのように、それ自体独立したデバイスを構成するものや、例えばカラーフィルター、電極層、誘電体層、絶縁層、半導体素子のように、デバイスの一部を構成するものであってもよい。

【0163】さらに、一次、二次転写体180, 200は、金属、セラミックス、石材、木材紙等の物質であってもよいし、ある品物を構成する任意の面上（時計の面上、エアコンの表面上、プリント基板の上等）、さらには壁、柱、天井、窓ガラス等の構造物の表面上であってもよい。

【0164】[追加工程2]次に、図34に示すように、第2分離層である熱溶融性接着層160を加熱し、熱溶融させる。この結果、熱溶融性接着層160の接着力が弱まるため、一次転写体180を、薄膜デバイス層140により離脱させることができる。なお、一次転写体180に付着した熱溶融性接着剤を除去することで、この一次転写体180を繰り返し再利用することができる。

【0165】第2分離層160として上述した水溶性接着剤を用いた場合には、少なくとも第2分離層160を含む領域を水と接触させればよく、好ましくは純水に浸せばよい。第2分離層160として上述した有機溶剤溶融性接着剤を用いた場合には、少なくとも第2分離層160を含む領域を有機溶剤と接触させればよい。第2分

離層160として上述した加熱または紫外線照射により剥離作用を呈する接着剤を用いた場合には、少なくとも第2分離層160を含む領域を、他の層を介して加熱または紫外線照射すればよい。また、第2分離層として第1分離層120と同様にアプレーション層を用いた場合には、光照射によって第2分離層160に剥離現象を生じさせる。このとき、注入イオンの効果によりその剥離が促進される。

【0166】[追加工程3]最後に、薄膜デバイス層140の表面に付着した第2分離層160を除去することで、図35に示すように、二次転写体200に転写された薄膜デバイス層140を得ることができる。ここで、この二次転写体200に対する薄膜デバイス層140の積層関係は、図2に示すように当初の基板100に対する薄膜デバイス層140の積層関係と同じとなる。

【0167】以上のような各工程を経て、被転写層（薄膜デバイス層）140の二次転写体200への転写が完了する。その後、被転写層（薄膜デバイス層）140に隣接するSiO₂膜の除去や、被転写層140上への配線等の導電層や所望の保護膜の形成等を行うこともできる。

【0168】第2の実施の形態では、被剥離物である被転写層（薄膜デバイス層）140自体を直接に剥離するのではなく、第1分離層120及び第2分離層160において分離して二次転写体200に転写するため、被分離物（被転写層140）の特性、条件等にかかわらず、容易かつ確実に、しかも均一に転写することができ、分離操作に伴う被分離物（被転写層140）へのダメージもなく、被転写層140の高い信頼性を維持することができる。

【0169】<第3の実施の形態>上述の第1、第2の実施の形態で説明した技術を用いると、例えば、図19(a)に示すような、薄膜デバイスを用いて構成されたマイクロコンピュータを所望の基板上に形成できるようになる。

【0170】図19(a)では、プラスチック等からなるフレキシブル基板182上に、薄膜デバイスを用いて回路が構成されたCPU300, RAM320, 入出力回路360ならびに、これらの回路の電源電圧を供給するための、アモルファスシリコンのPIN接合を具備する太陽電池340が搭載されている。

【0171】図19(a)のマイクロコンピュータはフレキシブル基板上に形成されているため、図19(b)に示すように曲げに強く、また、軽量であるために落下にも強いという特徴がある。

【0172】<第4の実施の形態>本実施の形態では、上述の薄膜デバイスの転写技術を用いて、図20, 図21に示されるような、アクティブマトリクス基板を用いたアクティブマトリクス型の液晶表示装置を作成する場合の製造プロセスの例について説明する。

【0173】(液晶表示装置の構成) 図20に示すように、アクティブマトリクス型の液晶表示装置は、バックライト等の照明光源400、偏光板420、アクティブマトリクス基板440、液晶460、対向基板480、偏光板500を具備する。

【0174】なお、本発明のアクティブマトリクス基板440と対向基板480にプラスチックフィルムのようなフレキシブル基板を用いる場合は、照明光源400に代えて反射板を採用した反射型液晶パネルとして構成すると、可撓性があつて衝撃に強くかつ軽量なアクティブマトリクス型液晶パネルを実現できる。なお、画素電極を金属で形成した場合、反射板および偏光板420は不要となる。

【0175】本実施の形態で使用するアクティブマトリクス基板440は、画素部442にTFTを配置し、さらに、ドライバ回路(走査線ドライバおよびデータ線ドライバ)444を搭載したドライバ内蔵型のアクティブマトリクス基板である。

【0176】このアクティブマトリクス型液晶表示装置の要部の断面図が図21に示され、また、液晶表示装置の要部の回路構成が図22に示される。

【0177】図22に示されるように、画素部442は、ゲートがゲート線G1に接続され、ソース・ドレンの一方がデータ線D1に接続され、ソース・ドレンの他方が液晶460に接続されたTFT(M1)と、液晶460とを含む。

【0178】また、ドライバ部444は、画素部のTFT(M1)と同じプロセスにより形成されるTFT(M2)を含んで構成される。

【0179】図21の左側に示されるように、画素部442におけるTFT(M1)は、ソース・ドレン層1100a、1100bと、チャンネル1100eと、ゲート絶縁膜1200aと、ゲート電極1300aと、絶縁膜1500と、ソース・ドレン電極1400a、1400bとを含んで構成される。

【0180】なお、参照番号1700は画素電極であり、参照番号1702は画素電極1700が液晶460に電圧を印加する領域(液晶への電圧印加領域)を示す。図中、配向膜は省略してある。画素電極1700はITO(光透過型の液晶パネルの場合)あるいはアルミニウム等の金属(反射型の液晶パネルの場合)により構成される。また、図21では、液晶への電圧印加領域1702において、画素電極1700の下の下地絶縁膜(中間層)1000は完全に除去されているが、必ずしもこれに限定されるものではなく、下地絶縁膜(中間層)1000が薄いために液晶への電圧印加の妨げにならない場合には残してもよい。

【0181】また、図21の右側に示されるように、ドライバ部444を構成するTFT(M2)は、ソース、ドレン層1100c、1100dと、チャンネル

1100fと、ゲート絶縁膜1200bと、ゲート電極1300bと、絶縁膜1500と、ソース・ドレン電極1400c、1400dとを含んで構成される。

【0182】なお、図21において、参照番号480は、例えば、対向基板(例えば、ソーダガラス基板)であり、参照番号482は共通電極である。また、参照番号1000はSiO₂膜であり、参照番号1600は層間絶縁膜(例えば、SiO₂膜)であり、参照番号1800は接着層である。また、参照番号1900は、例えばソーダガラス基板からなる基板(転写体)である。

【0183】(液晶表示装置の製造プロセス)以下、図21の液晶表示装置の製造プロセスについて、図23～図27を参照して説明する。

【0184】まず、図8～図18と同様の製造プロセスを経て、図23のようなTFT(M1, M2)を、信頼性が高くかつレーザー光を透過する基板(例えば、石英基板)3000上に形成し、保護膜1600を構成する。なお、図23において、参照番号3100は、剥離促進用イオンが注入されている分離層(レーザー吸収層)である。また、図23では、TFT(M1, M2)は共にn型のMOSFETとしている。但し、これに限定されるものではなく、p型のMOSFETや、CMOS構造としてもよい。

【0185】次に、図24に示すように、保護膜1600および下地絶縁膜1000を選択的にエッティングし、選択的に開口部4000, 4200を形成する。これらの2つの開口部は共通のエッティング工程を用いて同時に形成する。なお、図24では開口部4200において、下地絶縁膜(中間層)1000を完全に除去しているが、必ずしもこれに限定されるものではなく、下地絶縁膜(中間層)1000が薄いために液晶への電圧印加の妨げにならない場合には残してもよい。

【0186】次に、図25に示すように、ITO膜あるいはアルミニウム等の金属からなる画素電極1700を形成する。ITO膜を用いる場合には透過型の液晶パネルとなり、アルミニウム等の金属を用いる場合には反射型の液晶パネルとなる。次に、図26に示すように、接着層1800を介して基板1900を接合(接着)する。

【0187】次に、図26に示すように、基板3000の裏面からエキシマレーザー光を照射し、剥離促進用イオンによる作用も利用して分離層120に剥離現象を生じさせる。この後、基板3000を引き剥がす。このとき、引き剥がしにさほど力を要しないので、TFTなどには機械的ダメージが生じない。

【0188】次に、分離層(レーザー吸収層)3100を除去する。これにより、図27に示すようなアクティブマトリクス基板440が完成する。画素電極1700の底面(参照番号1702の領域)は露出しており、液晶との電気的な接続が可能となっている。この後、アク

ティプマトリクス基板440の絶縁膜(SiO₂などの中間層)1000の表面および画素電極1702表面に配向膜を形成して配向処理が施される。図27では、配向膜は省略してある。

【0189】そして、さらにその表面に画素電極1709と対向する共通電極が形成され、その表面が配向処理された対向基板480と図21のアクティブマトリク基板440とを封止材(シール材)で封止し、両基板の間に液晶を封入して、図21に示すような液晶表示装置が完成する。

【0190】<第5の実施の形態>図28に本発明の第5の実施の形態を示す。

【0191】本実施の形態では、上述の薄膜デバイスの転写方法を複数回実行して、転写元の基板よりも大きい基板(転写体)上に薄膜デバイスを含む複数のパターンを転写し、最終的に大規模なアクティブマトリクス基板を形成する。

【0192】つまり、大きな基板7000上に、複数回の転写を実行し、画素部7100a～7100Pを形成する。図28の上側に一点鎖線で囲んで示されるように、画素部には、TFTや配線が形成されている。図28において、参照番号7210は走査線であり、参照番号7200は信号線であり、参照番号7220はゲート電極であり、参照番号7230は画素電極である。

【0193】信頼性の高い基板を繰り返し使用し、あるいは複数の第1の基板を使用して薄膜パターンの転写を複数回実行することにより、信頼性の高い薄膜デバイスを搭載した大規模なアクティブマトリクス基板を作成できる。

【0194】<第6の実施の形態>本発明の第6の実施の形態を図29に示す。

【0195】本実施の形態の特徴は、上述の薄膜デバイスの転写方法を複数回実行して、転写元の基板上よりも大きな基板上に、設計ルール(つまりパターン設計するまでのデザインルール)が異なる薄膜デバイス(つまり、最小線幅が異なる薄膜デバイス)を含む複数のパターンを転写することである。

【0196】図29では、ドライバー搭載のアクティブマトリクス基板において、画素部(7100a～7100p)よりも、より微細な製造プロセスで作成されたドライバ回路(8000～8032)を、複数回の転写によって基板6000の周囲に作成してある。

【0197】ドライバ回路を構成するシフトレジスタは、低電圧下においてロジックレベルの動作をするので画素TFTよりも耐圧が低くてよく、よって、画素TFTより微細なTFTとなるようにして高集積化を図ることができる。

【0198】本実施の形態によれば、設計ルールレベルの異なる(つまり製造プロセスが異なる)複数の回路を、一つの基板上に実現できる。なお、シフトレジスタ

の制御によりデータ信号をサンプリングするサンプリング手段(図22の薄膜トランジスタM2)は、画素TFT同様に高耐圧が必要なので、画素TFTと同一プロセス/同一設計ルールで形成してもよい。

【0199】

【実施例】次に、本発明の具体的実施例について説明する。

【0200】(実施例1) 縦50mm×横50mm×厚さ

1.1mmの石英基板(軟化点: 1630°C、歪点: 1070°C、エキシマレーザの透過率: ほぼ100%)を用意し、この石英基板の片面に、分離層(レーザ光吸収層)として非晶質シリコン(a-Si)膜を低圧CVD法(Si₂H₆ガス、425°C)により形成した。分離層の膜厚は、100nmであった。

【0201】次に、分離層上に、中間層としてSiO₂膜をECR-CVD法(SiH₄+O₂ガス、100°C)により形成した。中間層の膜厚は、200nmであった。

【0202】次に、中間層上に、被転写層として膜厚5

200nmの非晶質シリコン膜を低圧CVD法(Si₂H₆ガス、425°C)により形成し、この非晶質シリコン膜にレーザ光(波長308nm)を照射して、結晶化させ、ポリシリコン膜とした。その後、このポリシリコン膜に対し、所定のパターンニングを施し、薄膜トランジスタのソース・ドレイン・チャネルとなる領域を形成した。この後、TEOS-CVD法(SiH₄+O₂ガス)により1200nmのゲート絶縁膜SiO₂を形成した後、ゲート絶縁膜上にゲート電極(ポリシリコンにMo等の高融点金属が積層形成された構造)を形成し、ゲート電極

30をマスクとしてイオン注入することによって、自己整合的(セルファライン)にソース・ドレイン領域を形成し、薄膜トランジスタを形成した。このとき同時に、水素イオンを分離層に注入した。この後、必要に応じて、ソース・ドレイン領域に接続される電極及び配線、ゲート電極につながる配線が形成される。これらの電極や配線にはA1が使用されるが、これに限定されるものではない。また、後工程のレーザー照射によりA1の溶融が心配される場合は、A1よりも高融点の金属(後工程のレーザー照射により溶融しないもの)を使用してもよい。

【0203】次に、前記薄膜トランジスタの上に、紫外線硬化型接着剤を塗布し(膜厚: 100μm)、さらにその塗膜に、転写体として縦200mm×横300mm×厚さ1.1mmの大型の透明なガラス基板(ソーダガラス、軟化点: 740°C、歪点: 511°C)を接合した後、ガラス基板側から紫外線を照射して接着剤を硬化させ、これらを接着固定した。

【0204】次に、Xe-C₁エキシマレーザ(波長: 308nm)を石英基板側から照射し、図31以降に示すビームスキャンを実施することで、分離層に剥離(層内

剥離および界面剥離)を生じさせた。照射したXe-C₁エキシマレーザのエネルギー密度は、250mJ/cm²、照射時間は、20nsecであった。なお、エキシマレーザの照射は、スポットビーム照射とラインビーム照射があり、スポットビーム照射の場合は、所定の単位領域(例えば8mm×8mm)にスポット照射し、このスポット照射を、各回の照射領域が重ならないように(前後左右にて重ならないように)ビーム走査しながら照射していく。また、ラインビーム照射の場合は、所定の単位領域(例えば378mm×0.1mmや378mm×0.3mm(これらはエネルギーの90%以上が得られる領域))と同じく、各回の照射領域が重ならないようにビーム走査しながら照射していく。

【0205】この後、石英基板とガラス基板(転写体)とを分離層において引き剥がし、石英基板上に形成された薄膜トランジスタおよび中間層を、ガラス基板側に転写した。

【0206】その後、ガラス基板側の中間層の表面に付着した分離層を、エッティングや洗浄またはそれらの組み合わせにより除去した。また、石英基板についても同様の処理を行い、再使用に供した。

【0207】なお、転写体となるガラス基板が石英基板より大きな基板であれば、本実施例のような石英基板からガラス基板への転写を、平面的に異なる領域に繰り返して実施し、ガラス基板上に、石英基板に形成可能な薄膜トランジスタの数より多くの薄膜トランジスタを形成することができる。さらに、ガラス基板上に繰り返し積層し、同様により多くの薄膜トランジスタを形成することができる。

【0208】(実施例2) 分離層を、分離層形成プロセスにてH(水素)を20at%含有する非晶質シリコン膜とした以外は実施例1と同様にして、薄膜トランジスタの転写を行った。

【0209】なお、非晶質シリコン膜中のH量の調整は、低圧CVD法による成膜時の条件を適宜設定することにより行った。

【0210】(実施例3) 分離層を、スピノコートによりソルゲル法で形成したセラミックス薄膜(組成:PbTiO₃、膜厚:200nm)とした以外は実施例1と同様にして、薄膜トランジスタの転写を行った。

【0211】(実施例4) 分離層を、スピノコートにより形成したセラミックス薄膜(組成:BaTiO₃、膜厚:400nm)とした以外は実施例1と同様にして、薄膜トランジスタの転写を行った。

【0212】(実施例5) 分離層を、レーザーAブレーキング法により形成したセラミックス薄膜(組成:Pb(Zr,Ti)O₃(PZT)、膜厚:50nm)とした以外は実施例1と同様にして、薄膜トランジスタの転写を行った。

【0213】(実施例6) 分離層を、スピノコートによ

り形成したポリイミド膜(膜厚:200nm)とした以外は実施例1と同様にして、薄膜トランジスタの転写を行った。

【0214】(実施例7) 分離層を、スピノコートにより形成したポリフェニレンサルファイド膜(膜厚:200nm)とした以外は実施例1と同様にして、薄膜トランジスタの転写を行った。

【0215】(実施例8) 分離層を、スペッタリングにより形成したAl層(膜厚:300nm)とした以外は実施例1と同様にして、薄膜トランジスタの転写を行った。

【0216】(実施例9) 照射光として、Kr-Fエキシマレーザ(波長:248nm)を用いた以外は実施例2と同様にして、薄膜トランジスタの転写を行った。なお、照射したレーザのエネルギー密度は、250mJ/cm²、照射時間は、20nsecであった。

【0217】(実施例10) 照射光として、Nd-YAGレーザ(波長:1068nm)を用いた以外は実施例2と同様にして薄膜トランジスタの転写を行った。なお、照射したレーザのエネルギー密度は、400mJ/cm²、照射時間は、20nsecであった。

【0218】(実施例11) 被転写層として、高温プロセス1000℃によるポリシリコン膜(膜厚80nm)の薄膜トランジスタとした以外は実施例1と同様にして、薄膜トランジスタの転写を行った。

【0219】(実施例12) 転写体として、ポリカーボネート(ガラス転移点:130℃)製の透明基板を用いた以外は実施例1と同様にして、薄膜トランジスタの転写を行った。

【0220】(実施例13) 転写体として、AS樹脂(ガラス転移点:70~90℃)製の透明基板を用いた以外は実施例2と同様にして、薄膜トランジスタの転写を行った。

【0221】(実施例14) 転写体として、ポリメチルメタクリレート(ガラス転移点:70~90℃)製の透明基板を用いた以外は実施例3と同様にして、薄膜トランジスタの転写を行った。

【0222】(実施例15) 転写体として、ポリエチレンテレフタレート(ガラス転移点:67℃)製の透明基板を用いた以外は、実施例5と同様にして、薄膜トランジスタの転写を行った。

【0223】(実施例16) 転写体として、高密度ポリエチレン(ガラス転移点:77~90℃)製の透明基板を用いた以外は実施例6と同様にして、薄膜トランジスタの転写を行った。

(実施例17) 転写体として、ポリアミド(ガラス転移点:145℃)製の透明基板を用いた以外は実施例9と同様にして、薄膜トランジスタの転写を行った。

【0224】(実施例18) 転写体として、エポキシ樹脂(ガラス転移点:120℃)製の透明基板を用いた以

外は実施例10と同様にして、薄膜トランジスタの転写を行った。

【0225】(実施例19)転写体として、ポリメチルメタクリレート(ガラス転移点:70~90℃)製の透明基板を用いた以外は実施例11と同様にして、薄膜トランジスタの転写を行った。

【0226】実施例1~19について、それぞれ、転写された薄膜トランジスタの状態を肉眼と顕微鏡とで観察したところ、いずれも、欠陥やムラがなく、均一に転写がなされていた。

【0227】以上述べたように、本発明の転写技術を用いれば、薄膜デバイス(被転写層)を種々の転写体へ転写することが可能となり、特に転写に必要な基板の剥離を過度の力を作用せずに無理なく行うことができた。これにより、例えば薄膜を直接形成することができないかまたは形成するのに適さない材料、成形が容易な材料、安価な材料等で構成されたものや、移動しにくい大型の物体等に対しても、転写によりそれを形成することができる。

【0228】特に、転写体は、各種合成樹脂や融点の低いガラス材のような、基板材料に比べ耐熱性、耐食性等の特性が劣るものを用いることができる。そのため、例えば、透明基板上に薄膜トランジスタ(特にポリシリコンTFT)を形成した液晶ディスプレイを製造するに際しては、基板として、耐熱性に優れる石英ガラス基板を用い、転写体として、各種合成樹脂や融点の低いガラス材のような安価でかつ加工のし易い材料の透明基板を用いることにより、大型で安価な液晶ディスプレイを容易に製造することができるようになる。このような利点は、液晶ディスプレイに限らず、他のデバイスの製造についても同様である。

【0229】また、以上のような利点を享受しつつも、信頼性の高い基板、特に石英ガラス基板のような耐熱性の高い基板に対し機能性薄膜のような被転写層を形成し、さらにはバターニングすることができるので、転写体の材料特性にかかわらず、転写体上に信頼性の高い機能性薄膜を形成することができる。

【0230】また、このような信頼性の高い基板は、高価であるが、それを再利用することも可能であり、よって、製造コストも低減される。

【0231】

【図面の簡単な説明】

【図1】本発明の薄膜デバイスの転写方法の第1の実施の形態における第1の工程を示す断面図である。

【図2】本発明の薄膜デバイスの転写方法の第1の実施の形態における第2の工程を示す断面図である。

【図3】本発明の薄膜デバイスの転写方法の第1の実施の形態における第3の工程を示す断面図である。

【図4】本発明の薄膜デバイスの転写方法の第1の実施の形態における第4の工程を示す断面図である。

【図5】本発明の薄膜デバイスの転写方法の第1の実施の形態における第5の工程を示す断面図である。

【図6】本発明の薄膜デバイスの転写方法の第1の実施の形態における第6の工程を示す断面図である。

【図7】第1の基板(図1の基板100)のレーザー光の波長に対する透過率の変化を示す図である。

【図8】図2の薄膜デバイスを形成するための第1の工程を示す断面図である。

【図9】図2の薄膜デバイスを形成するための第2の工程を示す断面図である。

【図10】図2の薄膜デバイスを形成するための第3の工程を示す断面図である。

【図11】図2の薄膜デバイスを形成するための第4の工程を示す断面図である。

【図12】図2の薄膜デバイスを形成するための第5の工程を示す断面図である。

【図13】図2の薄膜デバイスを形成するための第6の工程を示す断面図である。

【図14】図2の薄膜デバイスを形成するための第7の工程を示す断面図である。

【図15】図3に示す工程を詳細に示すための断面図である。

【図16】図4に示す工程の詳細を示すための断面図である。

【図17】図5に示す工程の詳細を示すための断面図である。

【図18】図6に示す工程の詳細を示すための断面図である。

【図19】(a), (b)は共に、本発明を用いて製造されたマイクロコンピュータの斜視図である。

【図20】液晶表示装置の構成を説明するための図である。

【図21】液晶表示装置の要部の断面構造を示す図である。

【図22】液晶表示装置の要部の構成を説明するための図である。

【図23】本発明を用いたアクティブマトリクス基板の製造方法の第1の工程を示すデバイスの断面図である。

【図24】本発明を用いたアクティブマトリクス基板の製造方法の第2の工程を示すデバイスの断面図である。

【図25】本発明を用いたアクティブマトリクス基板の製造方法の第3の工程を示すデバイスの断面図である。

【図26】本発明を用いたアクティブマトリクス基板の製造方法の第4の工程を示すデバイスの断面図である。

【図27】本発明を用いたアクティブマトリクス基板の製造方法の第5の工程を示すデバイスの断面図である。

【図28】本発明の薄膜デバイスの転写方法の他の例を説明するための図である。

【図29】本発明の薄膜デバイスの転写方法のさらに他の例を説明するための図である。

【図30】本発明の薄膜デバイスの転写方法の変形例を説明するための図である。

【図31】図9の工程の後に実施される剥離促進用イオンの注入工程を示す断面図である。

【図32】図10の工程の後に実施される剥離促進用イオンの注入工程を示す断面図である。

【図33】図6の工程に引き続いて行われる二度転写時の追加工程1を示す概略断面図である。

【図34】図33の工程に引き続いて行われる二度転写

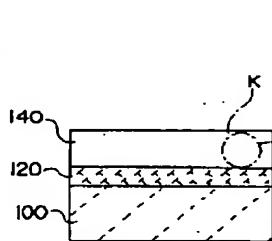
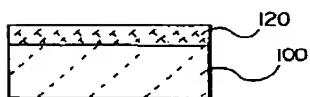
時の追加工程2を示す概略断面図である。

【図35】図34の工程に引き続いて行われる二度転写時の追加工程3を示す概略断面図である。

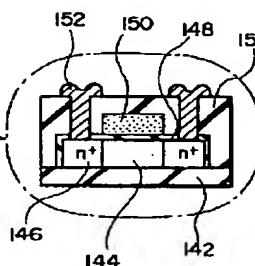
【符号の説明】

- 100 基板
- 120 分離層
- 140 薄膜デバイス層
- 160 接着層
- 180 転写体

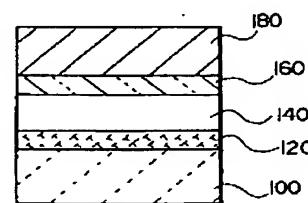
【図1】



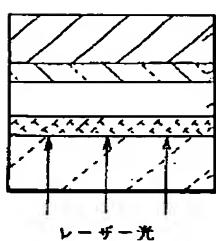
【図2】



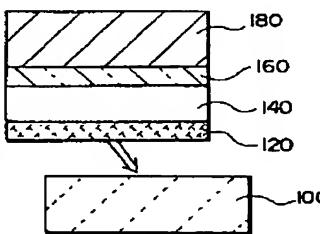
【図3】



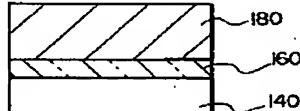
【図4】



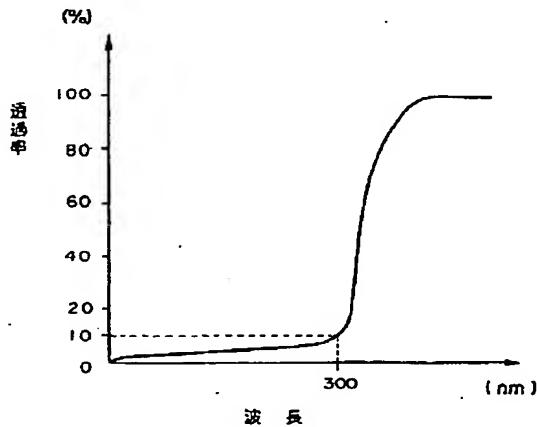
【図5】



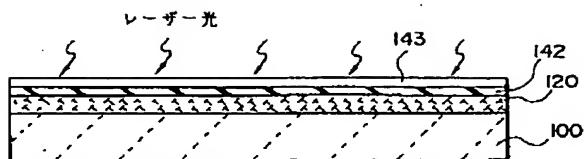
【図6】



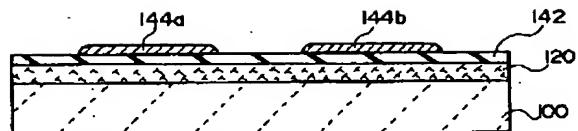
【図7】



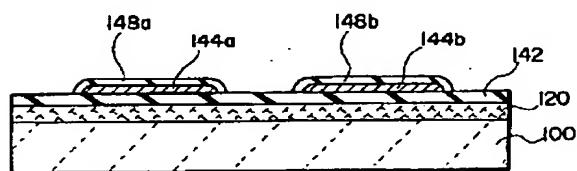
【図8】



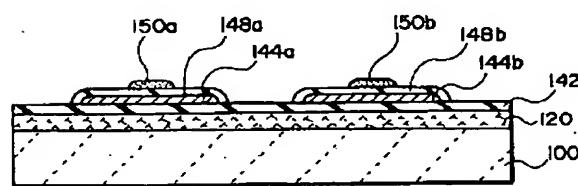
【図9】



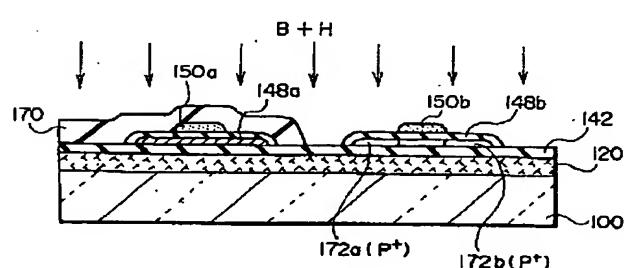
【図10】



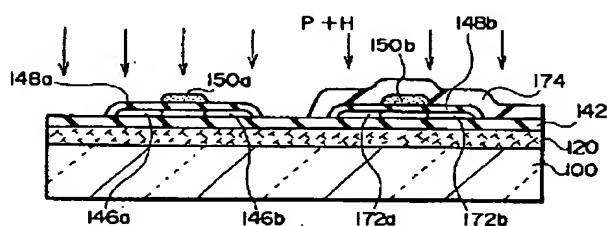
【図11】



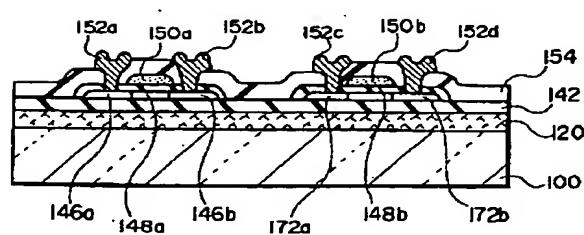
【図12】



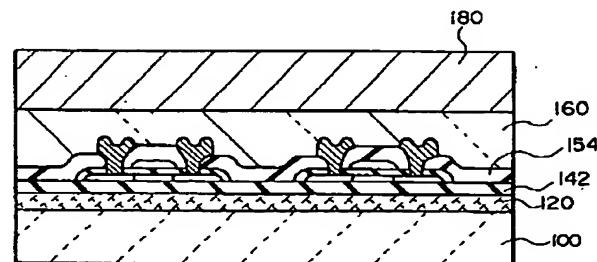
【図13】



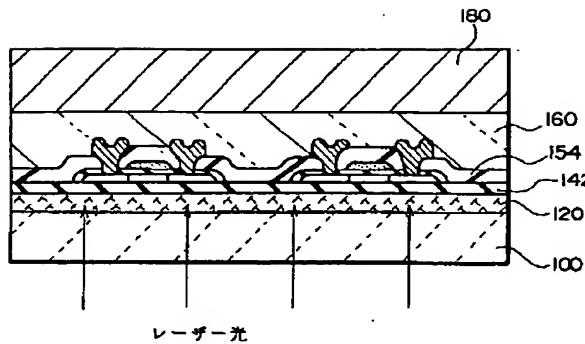
【図14】



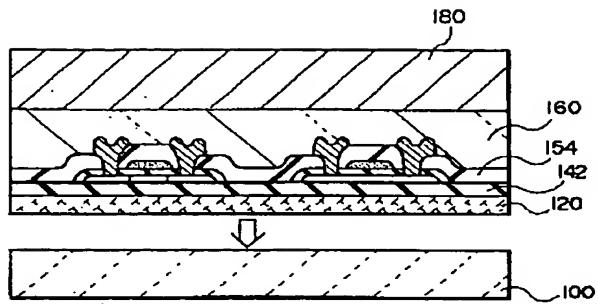
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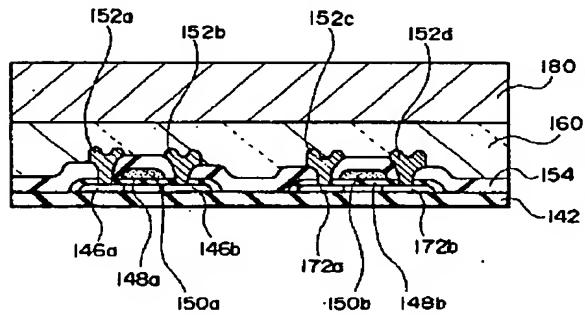
【図16】



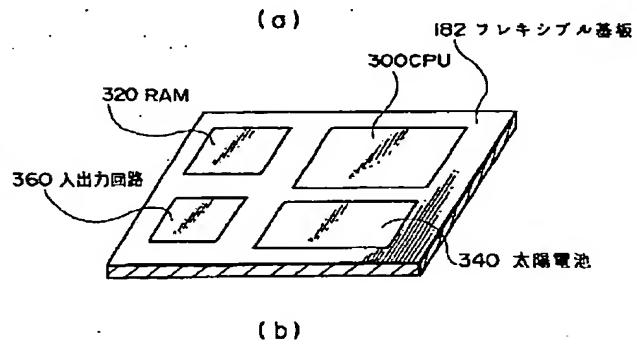
【図17】



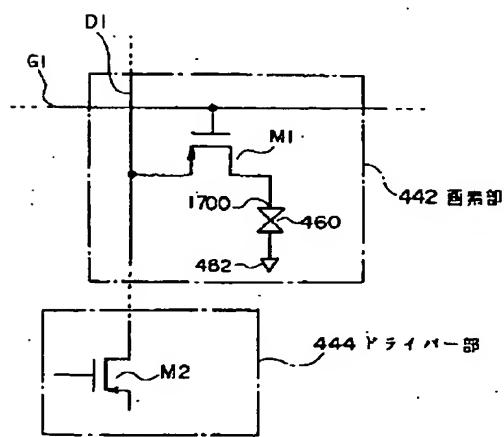
【図18】



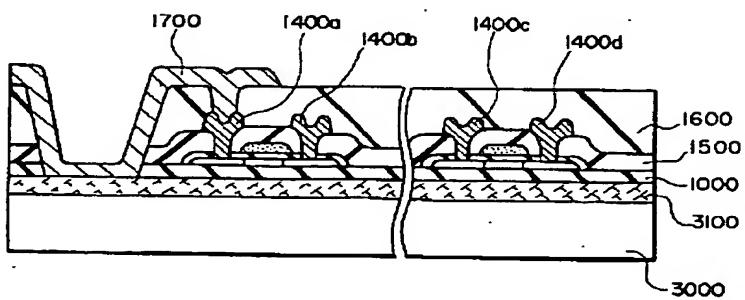
【図19】



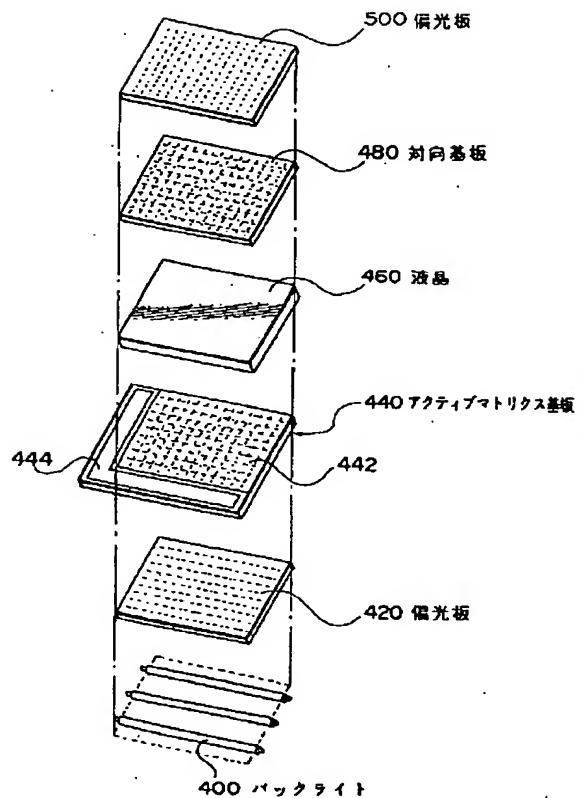
【図22】



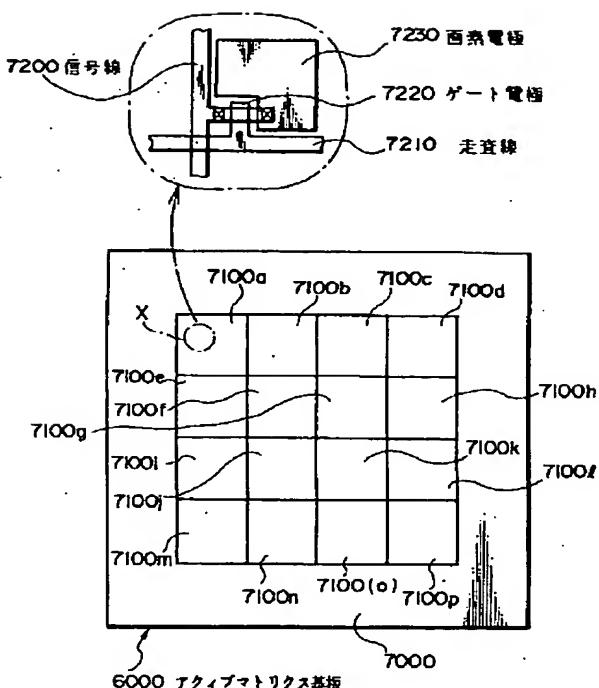
【図25】



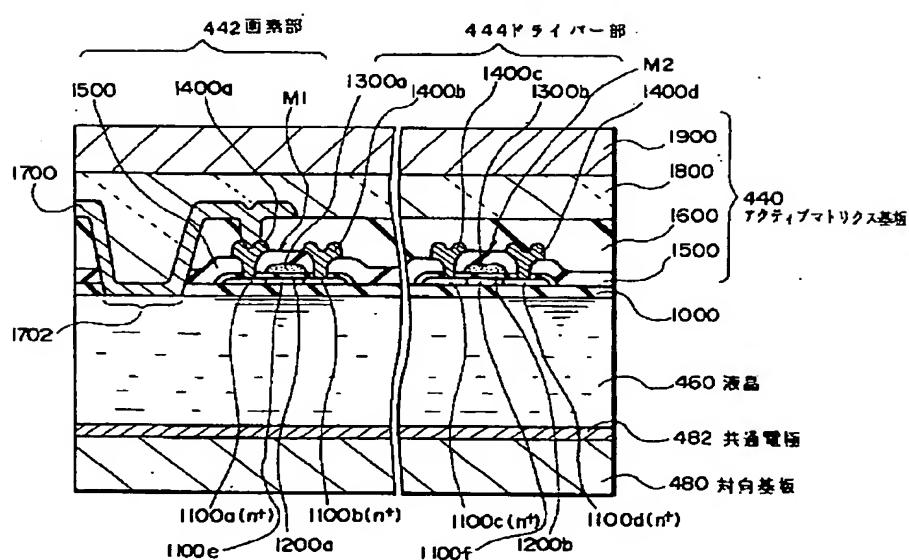
【図20】



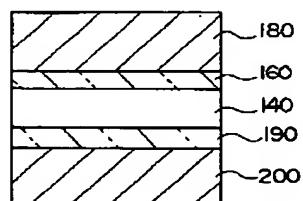
【図28】



【図21】



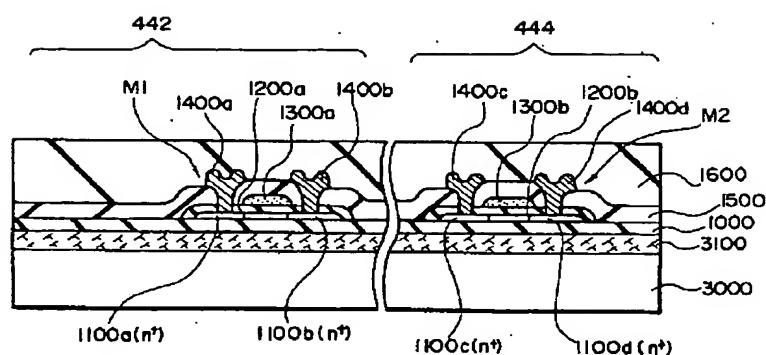
【図33】



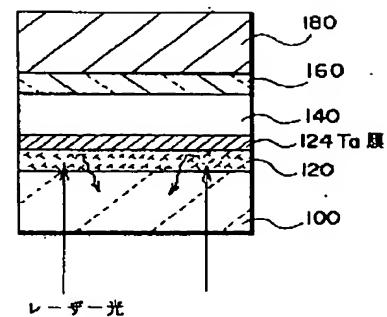
【図35】



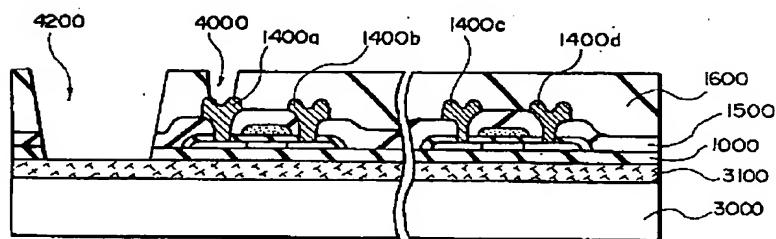
【図23】



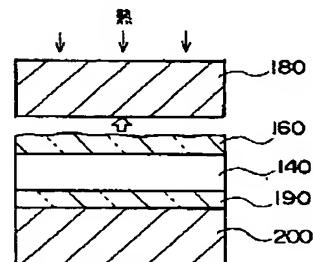
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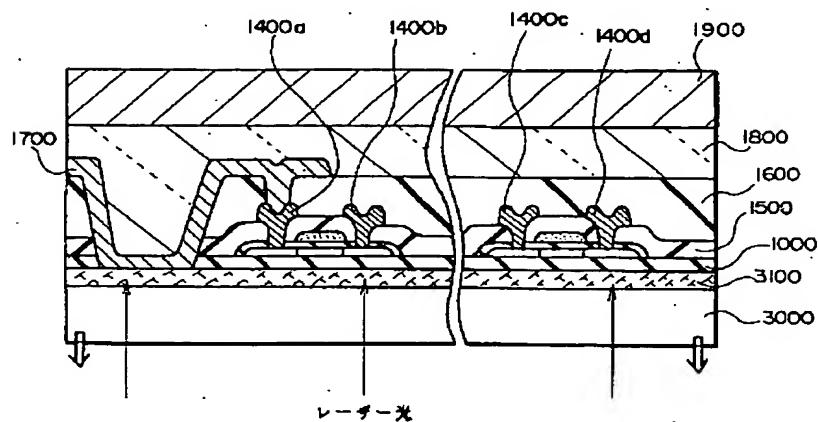
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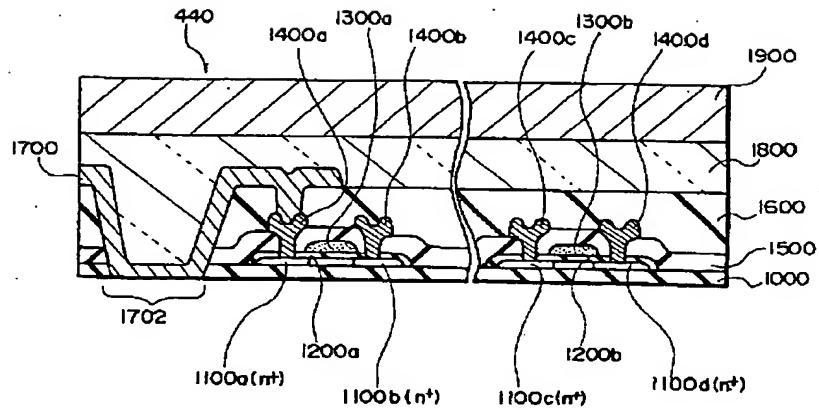
【図34】



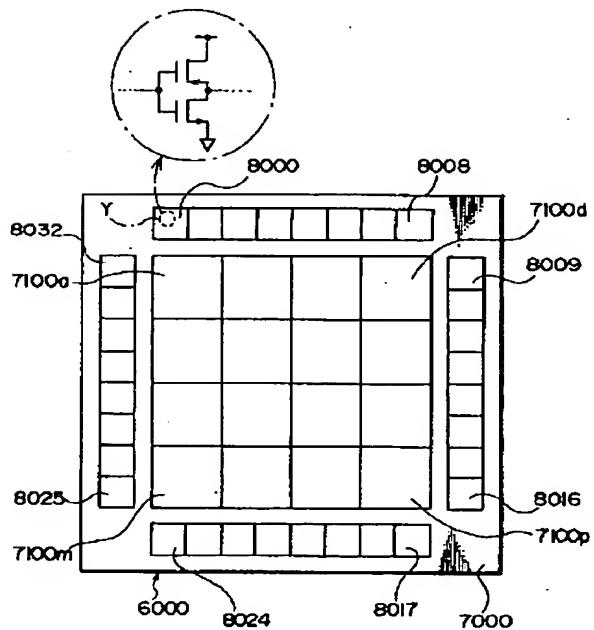
【図26】



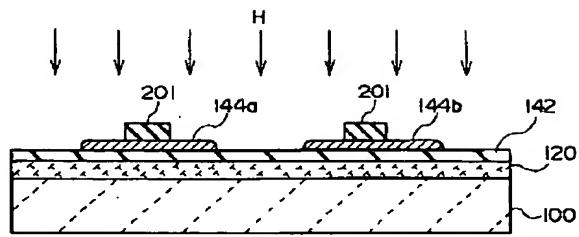
【図27】



【図29】



【図31】



【図32】

